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GOVERNMENT OF PUERTO RICO
PUERTO RICO PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: IN RE: REVIEW OF T&D OPERATOR'S SYSTEM OPERATION PRINCIPLES	**CASE NO. NEPR-MI-2021-0001** **SUBJECT: Motion to Submit System Operations Report**

MOTION TO SUBMIT SYSTEM OPERATIONS REPORT

TO THE PUERTO RICO ENERGY BUREAU:

COME NOW LUMA Energy, LLC[1], and **LUMA Energy ServCo, LLC**[2], (jointly referred to as "LUMA"), through the undersigned legal counsel and respectfully state and submit the following:

I. Introduction

1. The purpose of this motion is for LUMA to submit to this honorable Puerto Rico Energy Bureau of the Public Service Regulatory Board ("Energy Bureau"), for transparency and information purposes, a report prepared by LUMA titled "System Operations Report 2022" discussing important aspects of the operation of the Puerto Rico bulk power system from the period from June 1, 2021 until December 31, 2022, including LUMA's related efforts and progress as the operator of this system in accordance with the Puerto Rico Transmission and Distribution System Operation and Maintenance Agreement by and among LUMA, the Puerto Rico Electric Power Authority ("PREPA") and the Puerto Rico Public-Private Partnerships Authority dated as of June

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[1] Register No. 439372.
[2] Register No. 439373.

22, 2020 (the "T&D OMA") and the System Operation Principles submitted in this docket and approved by this Energy Bureau (as described further below).

II. Relevant Background

2. LUMA entered into the T&D OMA to "(i) provide management, operation, maintenance, repair, restoration and replacement, and other related services for [PREPA's transmission and distribution system ("T&D System")], in each case that are customary and appropriate for a utility transmission and distribution system service provider", and (ii) "establish policies, programs and procedures with respect thereto" ((i) and (ii), collectively, the "O&M Services"). *See* T&D OMA, Section 5.1. The O&M Services are to be provided in accordance with "Contract Standards"[3] (*see id*.), requiring compliance with Applicable Law[4], Prudent Utility Practice[5], and other standards, terms, conditions, and requirements specified in the T&D OMA (*see id*. at page 9).

[3] "Contract Standards" is defined as "the terms, conditions, methods, techniques, practices and standards imposed or required by: (i) Applicable Law; (ii) Prudent Utility Practice; (iii) applicable equipment manufacturer's specifications and reasonable recommendations; (iv) applicable insurance requirements under any insurance procured pursuant to [the T&D OMA]; (v) the Procurement Manuals, as applicable, and (vi) any other standard, term, condition or requirement specifically contracted in [the T&D OMA] to be observed by [LUMA]". *Id.* Section 1.1 at page 9.

[4] "Applicable Law" is defined as including "any foreign, national, federal, state, Commonwealth, municipal or local law, constitution, treaty, convention, statute, ordinance, code, rule, regulation, common law, case law or other similar requirement enacted, adopted, promulgated or applied by any [governmental body] …" in each case applicable to the parties to the T&D OMA. *Id.* at page 3.

[5] "Prudent Utility Practice" is defined, in pertinent part, as "at any particular time, the practices, methods, techniques, conduct and acts that, at the time they are employed, are generally recognized and accepted by companies operating in the United States electric transmission and distribution business as such practices, methods, techniques, conduct and acts appropriate to the operation, maintenance, repair and replacement of assets, facilities and properties of the type covered by the [T&D OMA] …" *Id.* at page 26.

3. As part of the O&M Services, and in its role as T&D System Operator (*see id*. Annex I, Section I(C)), LUMA is required to, "[a]s further detailed in, and in accordance with, the System Operation Principles," to:

> (i) dispatch, schedule and coordinate Power and Electricity[6] from available generation assets and provide related services; (ii) coordinate the scheduling of load requirements and Power and Electricity with [the Independent Power Producers or IPPs] pursuant to their respective Generation Supply Contracts[7] and with GenCo[8] pursuant to the GridCo-GenCo PPOA[9]; (iii) implement and apply, on a continuous basis on the relevant time basis applicable, the System Operation Principles in order to ensure and coordinate the delivery of Power and Electricity; (iv) develop load and energy forecasts (including daily forecasts), scheduling requirements and capacity requirements taking into consideration unit outages; (v) request and consider information with respect to operational constraints; and (vi) perform any other services related to the dispatch, scheduling or coordination of Power and Electricity from existing and future available generation assets.

Id. Section 5.13(a) (footnotes added).

4. In addition, in its role as T&D System Operator, LUMA is responsible for "managing control center operations, including generation scheduling and economic/reliable T&D System dispatch;… balancing the supply and demand of electricity, including reacting to changes

[6] "Power and Electricity" is defined as the "electrical energy, capacity and ancillary services available from the System Power Supply". *See id*. Section 1.1 at page 25. "System Power Supply," in turn, is defined as the "electric capacity, energy and ancillary services from any power supply sources authorized under Applicable Law to operate in the Commonwealth". *Id*. at page 30.

[7] The term "Generation Supply Contracts" is defined to include power purchase agreements and other contracts between PREPA and an IPP relating to the sale and purchase of Power and Electricity. *See id*. at page 17.

[8] "Genco" is defined as "the entity, which may be directly or indirectly owned by Owner or an Affiliate of Owner, that acquires or obtains ownership of the Legacy Generation Assets after the reorganization of PREPA". *Id*. at page 16. "Legacy Generation Assets" is defined as "any power plants and any facilities, equipment and other assets related to the generation of Power and Electricity existing as of the date [of the T&D OMA] and in which Owner or GenCo has an ownership or leasehold interest". *Id*. at page 19.

[9] "GridCo-GenCo PPOA" is defined as the "power purchase and operating agreement between GridCo and GenCo providing for expense reimbursement, power delivery and other services related to the generation, sale and purchase of Power and Electricity from the Legacy Generation Assets and the operation and maintenance thereof." *Id*. at page 17. "GridCo" is defined as "the entity, which may be directly or indirectly owned by Owner or an Affiliate of Owner, that acquires or obtains ownership of the T&D System after the reorganization of PREPA". *Id*.

in demand in real time, adjusting generation dispatch to be in balance with demand and maintaining the T&D System at safe operating levels in accordance with Prudent Utility Practices and System Operation Principles; …conduct[ing] T&D System planning activities; …develop[ing] and implement[ing] reliability standards appropriate for the conditions in Puerto Rico; and …manag[ing] a transparent, equitable and open generator interconnection process". *See id*. Annex I, Section I(C). The T&D operation services also include "management of T&D System generation interconnection applications and processing thereof (including negotiation and administration of generation interconnection agreements of any voltage class connected to the T&D System …". *See id*. Section (E)).

5. In connection with its role as System Operator, under Section 4.1(h) of the T&D OMA, LUMA was required, prior to commencing O&M Services, to prepare and submit to the Energy Bureau the System Operation Principles, described as "principles related to the dispatch of Power and Electricity" generally consistent with those set forth in Schedule I of Annex I of the T&D OMA and in accordance with other requirements set forth in the T&D OMA.

6. Pursuant to Section 4.1 of the T&D OMA, on February 25, 2021, LUMA filed with the Energy Bureau a *Petition for Approval of LUMA's System Operation Principles*.

7. After a series of procedural events, on May 19, 2021, LUMA submitted to this Energy Bureau a revised version of the System Operation Principles (this revised version, the "SOP") and fourteen (14) draft procedures. *See Motion in Compliance with Order Submitting Revised System Operation Principles, Phase I Draft Procedures and Additional Information* filed on that date.

8. As indicated in the SOP, this document "establishes rules and protocols to operate the [Bulk Power System] in accordance with Prudent Utility Practice and as economically as possible in consideration of available electricity supply", among other factors, and covers the areas of system and resource planning, data management, energy dispatch, operating parameters, energy management system, outage scheduling and reporting, emergency response and balancing frequency and system impacts. *See* SOP, Executive Summary. Among others, this document addresses the "rules by which interconnected facilities interact with the grid to ensure safe and reliable operations" (*see id*. Section 3.2) and provides for the development of "… procedures for controlling and preserving steady state power system stability based on an understanding of the factors that could threaten or disrupt service" (*see id*. Section 6.2).

9. On May 31, 2021, this Energy Bureau issued a Resolution and Order ("May 31st Resolution and Order") approving the SOP subject to certain conditions listed therein, including, among others, for LUMA to file an updated timeline for completion of any other procedure, protocol, manual or document necessary for the operation of the system, including the draft procedures filed by LUMA on May 19, 2021 (*see* May 31st Resolution and Order, pages 13-14); submit certain enhancements to the energy dispatch principles included in SOP 5.1 and 5.2 (*see id*. at page 14); and submit final versions of its load forecasting procedures to include certain specified information (*see id*.).

10. On June 1, 2021, LUMA commenced providing O&M Services pursuant to the T&D OMA.

11. On June 22, 2021, LUMA filed a request for clarification or reconsideration of certain portions of the May 31st Resolution and Order (*see Request for Clarifications and/or*

Reconsideration of Portions of May 31st Resolution and Order Approving LUMA's System Operations Principles) and submitted an updated timeline for completion of the fourteen (14) procedures submitted on May 19, 2021, identified as Phase I operating procedures, and fifteen (15) additional procedures identified as Phase II operating procedures (*see id*. at page 14) and the revised language of SOP 5.1 and 5.2 (*see id*.).

12. On August 25, 2021, this Energy Bureau issued a Resolution and Order wherein, among others and in relevant part, it ordered LUMA to file a revised version of SOP 5.1 and 5.2 and final versions of its Load Forecasting Procedures including the information specified therein.

13. On September 13, 2021, LUMA submitted explanations regarding SOPs 5.1 and 5.2 and regarding the efforts towards completion of the Load Forecasting Procedures. *See Motion in Attention to Resolution and Order of August 25, 2021 and Request for Agenda for the Virtual Technical Conference Scheduled for September 12, 2021* of that date.

14. On December 23, 2021, LUMA submitted the final versions of the fourteen (14) Phase I operating procedures and the fifteen (15) Phase II operating procedures, for a total of twenty-nine (29) operating procedures ("SOP Procedures"). *See Motion Submitting Operating Procedures and Request for Confidential Treatment* of that date.

15. On June 30, 2022, LUMA submitted a document titled Regulatory Long-Term Forecast Review. *See Motion Submitting "Regulatory Long-Term Forecast Review"* of June 30, 2022.

III. Submittal of System Operations Report

16. As part of LUMA's overall commitment to public transparency and for purposes of providing an overview to this Energy Bureau and the public on how Puerto Rico's bulk power

system has been managed by LUMA, in its role as System Operator, since it commenced providing O&M Services on June 1, 2021 and through December 31, 2022, LUMA has prepared the System Operations Report 2022 submitted herein. *See Exhibit 1* ("System Operations Report 2022"). Appendix A of *Exhibit 1* is submitted herein as *Exhibit 2*.

17. The System Operations Report 2022 describes the major circumstances or factors affecting the operation of the bulk power system during the mentioned time period, including: the most significant and positive changes made by LUMA as part of the transition of the Puerto Rico electric system from a vertically integrated model to the establishment of LUMA as System Operator in accordance with the T&D OMA (including efforts towards unbundling the T&D System from the generation system and to modernize and implement industry best practices) (*see id*. Executive Summary and Schedule B); generation demand and supply (being noted that, while generation is not LUMA's responsibility, an understanding of how generator units perform helps LUMA, as System Operator, to plan for the economic dispatch of available units, maintain adequate reserve levels, and operate the T&D System following Prudent Utility Practice) (*see id*. Section 1.0); fuel price variability and history and its impact on customers (being noted that LUMA is not responsible for the generation of electricity, fuel costs, and has no control over the impact of fuel costs on customer rates) (*see id*. Section 2.0); capacity additions and withdrawals (*see id*. Section 3.0); bulk power system performance, including the comprehensive capital investment programs established by LUMA to address aging/deteriorated infrastructure, improve reliability, and increase safety and security, while ensuring compliance with applicable laws and Prudent Utility Practice (*see id*. Section 4.0); resource adequacy (relating to the adequacy and inadequacy of generation resources in Puerto Rico's electric power system to inform strategic resource

planning decisions) (*see id*. Section 5.0); and compliance with the SOP, including bridging the gap between the "as-is" condition of the T&D system and what is necessary to operate the bulk power system in compliance with the SOP and management of system operations issues and SOP violations by generators (*see id*. Section 6.0).

18. LUMA trusts that this System Operations Report 2022 demonstrates the significant progress made by LUMA to modernizing the way the bulk power system is managed and LUMA's efforts to fully transform this system and modernize the grid.

WHEREFORE, LUMA respectfully requests that the Energy Bureau **take notice** of the aforementioned for all purposes, **accept** LUMA's System Operations Report 2022, and take any other action it may deem appropriate.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 23rd day of August 2023.

I hereby certify that I filed this motion using the electronic filing system of this Energy Bureau and that I will send an electronic copy of this motion to attorney for PREPA, Joannely Marrero-Cruz, jmarrero@diazvaz.law.

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Exhibit 1

System Operations Report 2022

Exhibit 2

Appendix A to System Operations Report 2022

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June 2021 – December 2022

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Resumen Ejecutivo en Español

Desde que asumió las operaciones del sistema de transmisión y distribución eléctrica de Puerto Rico el 1 de junio de 2021, LUMA ha estado transformando el sistema eléctrico para servir mejor a nuestros 1.5 millones de clientes y satisfacer las diversas necesidades energéticas de Puerto Rico. Bajo el Acuerdo de Operación y Mantenimiento del Sistema de Transmisión y Distribución de Puerto Rico (T&D OMA, por sus siglas en inglés), LUMA sirve como el Operador del Sistema responsable de operar el sistema de transmisión y distribución eléctrica de la isla en tiempo real, incluyendo el despacho de centrales eléctricas y el flujo de energía a través del sistema eléctrico para mantener el equilibrio entre la oferta y la demanda. LUMA también lleva a cabo la planificación del sistema a corto y largo plazo, y proporciona información y datos sobre el suministro de energía y el rendimiento del Sistema Eléctrico a los clientes, el Negociado de Energía de Puerto Rico (el Negociado de Energía), la Autoridad para las Alianzas Público-Privadas de Puerto Rico (P3A), los legisladores y las partes interesadas.

Antes de asumir las operaciones, y de conformidad con el T&D OMA, LUMA presentó al Negociado de Energía los Principios de Operación del Sistema (SOP, por sus siglas en inglés), que fueron revisados, modificados y aprobados condicionalmente por el Negociado de Energía en el Caso No. NEPR-MI-2021-0001, Resolución y Orden del 31 de mayo de 2021. El SOP establece reglas y protocolos para operar el sistema de acuerdo con la Práctica Prudente de Utilidades, y de la forma más económica posible en consideración del suministro eléctrico disponible y otras restricciones del sistema. El rol de LUMA como Operador del Sistema, tal y como se recoge en el SOP, es consistente con la estructura legal y los requisitos regulatorios aplicables para la interacción entre la generación y el resto del sistema eléctrico. La independencia de LUMA de la tenencia y operación de la generación, así como el despacho no discriminatorio de la generación por parte del Operador del Sistema para satisfacer los objetivos de confiabilidad y economía, se traducen en beneficios tangibles para el cliente. El fomento de un sector de generación más competitivo y la aplicación de la política pública energética de Puerto Rico, incluida la separación de la generación de otras funciones en el sector eléctrico, busca proveer mayor eficiencia y una asignación más eficaz de los recursos que se traduzca en un servicio eléctrico de menor costo, sostenible, confiable y resiliente para el pueblo de Puerto Rico.

Este Informe de Operaciones del Sistema ofrece una visión general de cómo se ha gestionado el Sistema Eléctrico de Puerto Rico desde el inicio de las operaciones de LUMA el 1 de junio de 2021 hasta el 31 de diciembre de 2022. El informe proporciona datos históricos para que los participantes del sistema eléctrico de Puerto Rico, legisladores y clientes dispongan de la información necesaria para tomar decisiones informadas sobre el sistema eléctrico de Puerto Rico.

Procedimientos SOP

Antes de que LUMA asumiera las operaciones del sistema energético, la Autoridad de Energía Eléctrica de Puerto Rico (AEE) no contaba con procedimientos escritos para operar el Sistema Eléctrico de manera estandarizada. Aunque el personal de la AEE había operado el sistema eléctrico de Puerto Rico durante años con una comprensión de las cuestiones operativas en el Sistema Eléctrico, la falta de procedimientos y documentación adecuados hizo imposible asegurar una operación consistente bajo las normas prescritas.

Como parte de los trabajos inciales previo a comenzar a operar la red eléctrica, LUMA trabajó estrechamente con el personal de la AEE para documentar cómo se operaba la red. Este proceso informó la creación de 29 Procedimientos del SOP [1] cuyo objetivo general es implementar el SOP y permitir que el Sistema Eléctrico de Puerto Rico opere confiablemente, consistente con los Estándares de Contrato y Práctica Prudente de Utilidades, según definidos en el T&D OMA. Estos procedimientos se centraron en temas como la planificación del sistema, las normas operativas, la gestión de reservas, la planificación de contingencias, las operaciones de despacho, la gestión de interrupciones y la respuesta de emergencias para servir mejor a los 1.5 millones de clientes de LUMA y promover el objetivo de garantizar el funcionamiento confiable y rentable del sistema energético de Puerto Rico. Es importante destacar que el SOP y los Procedimientos del SOP se ajustan a las leyes de Puerto Rico, las órdenes reguladoras del Negociado de Energía y los requisitos emitidos por diversas agencias gubernamentales.

Dados los significativos retos heredados por LUMA, la principal prioridad que enfrenta el Operador del Sistema es avanzar el sistema energético existente para alcanzar los estándares mínimos de la industria, mientras apoya el cumplimiento del Plan de Acción Modificado del Plan Integrado de Recursos (PIR), de fecha 24 de agosto de 2020, que incluye el cambio de generación predominantemente basada en combustibles fósiles a sistemas renovables y de almacenamiento, así como eficiencia energética, respuesta a la demanda y generación distribuida. Como se refleja en nuestro apoyo al crecimiento y adopción de energía renovable, LUMA sigue enfocada en mejorar la confiabilidad y resiliencia mientras empodera la aceleración de energía renovable para construir el futuro de energía limpia que los puertorriqueños esperan y merecen.

Resumen del sistema

En 2022, como parte del compromiso general de LUMA con la transparencia pública, LUMA creó una página pública en su sitio web[2] para proporcionar información pública precisa y oportuna sobre el funcionamiento del sistema eléctrico. En la página web, los clientes y miembros del público pueden ver, en tiempo real, la demanda del sistema, la capacidad del sistema, las reservas y otros indicadores claves. LUMA también carga un informe mensual sobre el desempeño de las instalaciones de generación operadas por la AEE y los generadores privados en términos de Capacidad Disponible, Producción de Generación y Tasas de Salidas de Unidades, entre otros. Entender el desempeño de las unidades de generación ayuda al Operador del Sistema a implementar el despacho económico de las unidades disponibles, mantener niveles de reserva adecuados y operar el sistema de transmisión y distribución de manera segura y confiable.

Con respecto al rango de demanda de energía del sistema, la demanda (o carga) de los clientes de Puerto Rico suele oscilar entre 2,100 MW y 2,900 MW en los meses de verano, y entre 1,800 MW y 2,500 MW en los meses de invierno. El pico de demanda durante el periodo del 1 de junio de 2021 y el 30 de junio de 2022 fue de 2,972 MW en junio de 2021, y durante el periodo del 1 de julio de 2022 al 31 de diciembre de 2022 fue de 3,037 MW en agosto de 2022.

La capacidad disponible se refiere a la relación entre la producción máxima de una unidad disponible para ser despachada y la producción potencial máxima que puede generar una unidad. Durante el año fiscal 2022 y la primera mitad del 2023, la capacidad disponible se mantuvo en el 54%. Como

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[1] Los 29 Procedimientos SOP se prepararon y presentaron en su forma definitiva al Negociado de Energía el 23 de diciembre de 2021 en el Caso Núm NEPR-MI-2021-0001, en cumplimiento de la Resolución y Orden del Negociado de Energía del 31 de mayo de 2021.

[2] *Resumen del Sistema*. LUMA. (s.f.). https://lumapr.com/resumen-del-sistema/

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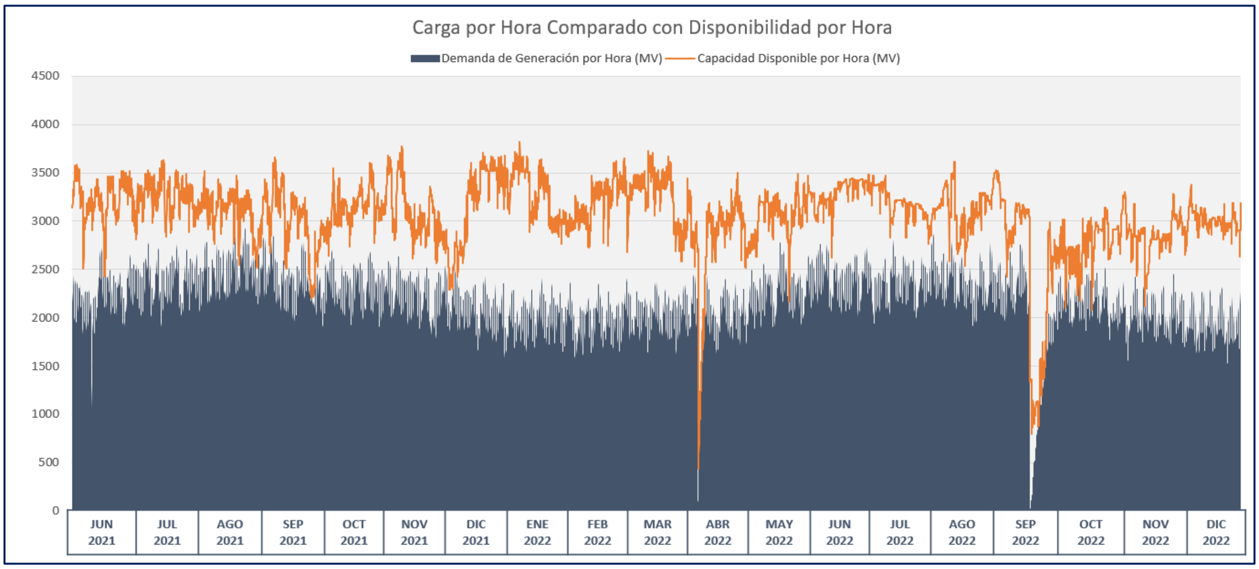
consecuencia de problemas con la generación, o de otros sucesos que afectan al suministro de energía, la falta de generación suficiente para satisfacer la demanda puede llevar a relevos de carga para garantizar la estabilidad de la red energética. Los relevos de carga se producen cuando no hay suficiente suministro de energía (generación) para satisfacer la demanda real (carga). Los relevos de carga se ilustran a continuación cuando la capacidad disponible (en naranja) llega al nivel de la demanda de generación (en azul). Cuando se produce un relevo de carga, el Centro de Operaciones de Transmisión (COT) reduce intencionadamente la demanda porque no hay suficiente generación para satisfacer la demanda, o la generación no puede ajustarse con la suficiente rapidez para mantener los parámetros técnicos del sistema, incluida la frecuencia del sistema, para prestar servicio de forma segura a todos los clientes.

Figura RE-1 – Demanda de generación comparada con la capacidad disponible



Las reservas del sistema son la cantidad de generación sobre la demanda actual disponible para hacer frente a un incremento de demanda inesperado o a una pérdida inesperada de generación. Según el SOP y las Prácticas Prudentes de Utilidades, el Operador del Sistema debe mantener un nivel mínimo de reservas de 750 MW. El Apéndice A muestra una gráfica de la cantidad de reservas por hora. Durante el periodo comprendido entre el 1 de junio de 2021 y el 31 de diciembre de 2022, el requisito de reservas se cumplió en el 65% de las horas.

Eventos significativos en 2022

A continuación, se resumen los acontecimientos significativos que afectaron al sistema eléctrico durante 2022:

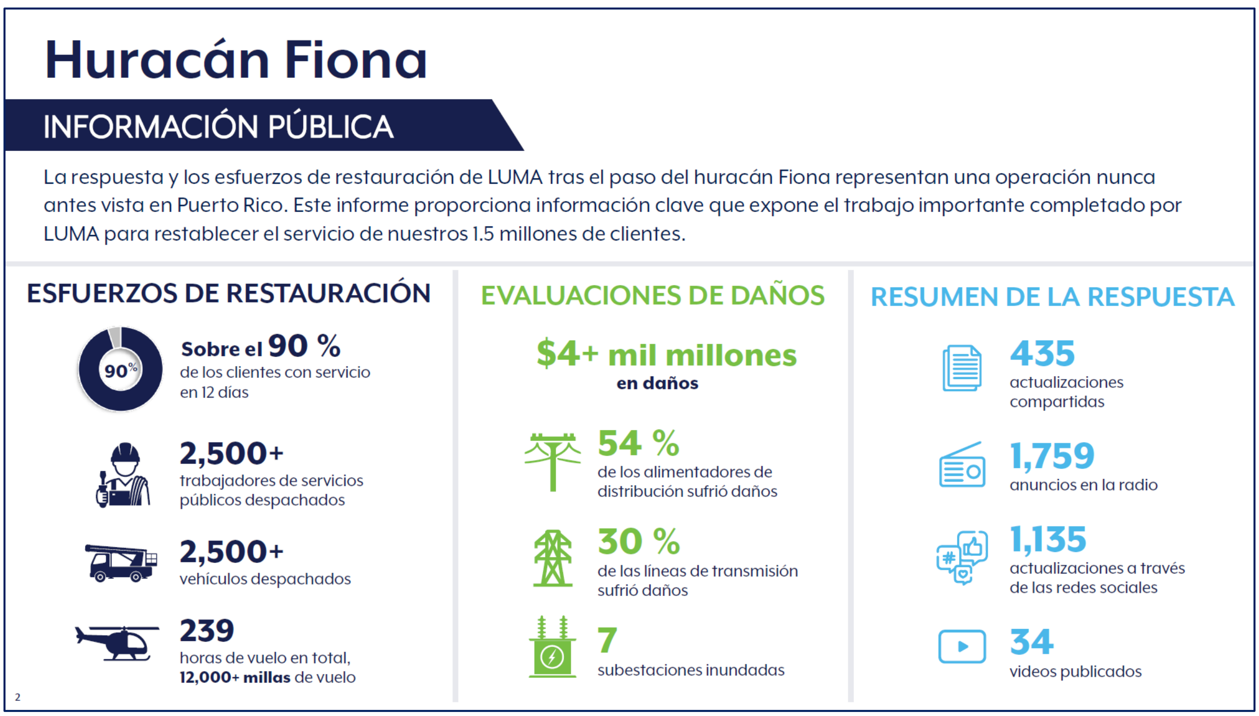
1. El 6 de abril de 2022, un fallo en el sistema eléctrico provocó un incendio en la subestación de transmisión de Costa Sur, el cual causó un apagón en todo el sistema eléctrico. Se presentó una investigación exhaustiva al Negociado de Energía.

2. El 18 de septiembre de 2022, un huracán de Categoría 1, el Huracán Fiona, pasó por Puerto Rico afectando a todo el sistema eléctrico.

a. El 6 de octubre de 2022, LUMA envió al Negociado de Energía una carta en la que expresó su preocupación por la disponibilidad de generación fiable tras el huracán Fiona y describíó el posible impacto significativo para los clientes si no se empleaban medidas de mitigación.

b. El 12 de octubre de 2022, el Negociado de Energía ordenó a LUMA preparar un plan de estabilización, en coordinación con PREPA y FEMA. Desde entonces, FEMA ha establecido el Grupo de Trabajo para la Estabilización del Sistema Eléctrico de Puerto Rico, quienes se han dado a la tarea de proveer a Puerto Rico generación temporera para aumentar la capacidad del sistema y completar las reparaciones necesarias para estabilizar el sistema sin interrupciones significativas de servicio.

Se puede encontrar más información sobre estos acontecimientos en el sitio web del Negociado de Energía, donde LUMA ha presentado numerosos informes y actualizaciones. Además, el público puede encontrar información sobre la respuesta de LUMA al Huracán Fiona y los esfuerzos de restauración en lumapr.com[3] .



Transición de la Utilidad de un Modelo Integrado Verticalmente a un Operador de Sistema

Con el inicio de LUMA como operador del sistema de transmisión y distribución eléctrica de Puerto Rico y como Operador del Sistema de la isla, el sistema eléctrico de Puerto Rico está experimentando un importante periodo de cambio para modernizarse e implantar las mejores prácticas de la industria. En varios aspectos, el sistema eléctrico de Puerto Rico ya ha visto cambios en un solo año que a muchas

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[3] Resumen de la Respuesta y la Restauración Tras el Huracán Fiona, LUMA. https://lumapr.com/resumen-de-la-respuesta-y-la-restauracion-tras-el-huracan-fiona/

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otras empresas de servicios públicos les ha llevado muchos años aplicar. Entre los cambios más significativos se encuentra la separación del sistema de transmisión y distribución del sistema de generación. Aunque varios aspectos de esta transformación aún están en proceso de completarse, incluyendo la reorganización del negocio de Generación de la AEE en una compañía generadora (GenCo), la magnitud de los cambios que se han implementado es significativa.

Es importante reconocer que el proceso de desagregación de las empresas de servicios públicos integradas verticalmente en Norteamérica y en todo el mundo suele llevar de muchos años a décadas de planificación y aplicación. Los estudios académicos y varios estudios regulatorios han demostrado que la desagregación conduce finalmente a mejoras significativas en la eficiencia que reducen el costo total suministrado a los clientes. Sin embargo, la transición en sí es un proceso difícil que en muchos casos ha requerido ajustes.

En Puerto Rico, la desagregación de la empresa de servicios públicos AEE, integrada verticalmente, exigió el desarrollo de muchas políticas y procedimientos diferentes que nunca antes habían existido. La creación de estas políticas y procedimientos es un primer paso fundamental. La plena implantación total de los cambios de comportamiento descritos en estos procedimientos llevará tiempo. La mayoría de los cambios se implantementaron en un contexto de importantes interrupciones operativas de la generación y relevos de carga a los que muy pocas empresas de servicios públicos se enfrentan. En el próximo año fiscal, LUMA, los generadores y otros participantes en el sistema eléctrico se basarán en estos primeros pasos fundacionales para institucionalizar el cumplimiento de los procedimientos y la documentación, aumentar la publicación de informes de análisis y datos operativos y evaluar el rendimiento. La mejora continua y la búsqueda de la excelencia permitirán a los clientes beneficiarse más plenamente de la transformación de la desagregación. Una vez aplicada con éxito, la red estará en condiciones de incorporar una transformación aún mayor en los próximos años, a medida que avance hacia una cartera de recursos libres de carbono.

A continuación se enumeran los cambios operativos más significativos y positivos realizados por LUMA en sus primeros 18 meses de operaciones. Se explican con más detalle en el Apéndice B. Para cada uno de estos cambios importantes, esta sección describe las "Condiciones heredadas", que es lo que existía antes de que LUMA se hiciera cargo, y las "Mejoras del sistema", que describen la evaluación de la situación que existe en la actualidad.

Entre los principales cambios introducidos por LUMA, se incluyen los siguientes:

1. Acuerdos desarrollados entre la AEE y LUMA para separar los activos de generación de los activos de T&D, incluyendo el Acuerdo Operativo PREPA-GenCo-HydroCo, los Procedimientos Operativos Acordados y el Plan de Demarcación detallado.

2. Creación de Comités de Partes Interesadas Térmicas y Renovables para proporcionar a los Productores Independientes de Energía de Generación un foro para discutir problemas y mejoras con LUMA como Operador del Sistema.

3. Implementación de procesos y procedimientos para tratar a todos los generadores por igual y de forma no discriminatoria

4. Introducción de herramientas para un mejor despacho económico con restricciones de seguridad, incluyendo programas para la instalación de un nuevo Sistema de Gestión de Energía para una mejor visibilidad del sistema y control directo, Control Automático de Generadores para que las unidades de generación puedan hacer ajustes rápidos a la salida para mantener los parámetros de funcionamiento del sistema sin afectar a los clientes, y procesos de decisión no discriminatorios para las operaciones del sistema

5. Mejor conocimiento y comprensión de la reserva de generación necesaria para operar el Sistema Eléctrico de acuerdo con las Prácticas Prudentes de Utilidad

6. Creación del primer Estudio de Adecuación de Recursos para cuantificar las deficiencias de recursos y su impacto en el Sistema Eléctrico.

7. Mejora de las prácticas de gestión de datos que permiten la toma de decisiones basada en datos

8. Creación de nuevas políticas y requisitos estandarizados para la interconexión de nuevos generadores al sistema.

Desde asumir las operaciones del sistema de transmisión y distribución de Puerto Rico, y como Operador del Sistema de Puerto Rico, los más de 3,000 hombres y mujeres de LUMA han superado importantes obstáculos y desafíos para mejorar el servicio eléctrico. Si bien se ha logrado un progreso significativo en la modernización de la forma en que se gestiona el Sistema Eléctrico, los esfuerzos para transformar completamente el sistema y modernizar la red son y seguirán siendo el enfoque en los próximos meses y años. LUMA sigue absolutamente comprometida con la construcción de un sistema energético que opere de forma eficiente y eficaz para el beneficio de los 1.5 millones de clientes a los que tiene el privilegio de servir.

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Executive Summary

Since assuming operations of Puerto Rico's electric transmission and distribution system on June 1, 2021, LUMA has been transforming the electric system to better serve our 1.5 million customers and meet the diverse energy needs of Puerto Rico. Under the Puerto Rico Transmission and Distribution Operation and Maintenance Agreement (T&D OMA), LUMA serves as the System Operator who manages the real-time operation of the Bulk Power System (BPS), including dispatch of power plants and flow of power over the electric system to maintain supply and demand in balance. LUMA also carries out short-term and long-term system planning, and provides information and data on the supply of energy and performance of the BPS to customers, the Puerto Rico Energy Bureau (the Energy Bureau or PREB), the Puerto Rico Public-Private Partnership Authority (P3A), policymakers, and stakeholders.

Before assuming operations, and in accordance with the T&D OMA, LUMA presented to the Energy Bureau the System Operation Principles (SOP), which were reviewed, modified and conditonally approved by the Energy Bureau in Case No. NEPR-MI-2021-0001, Resolution and Order of May 31, 2021. The SOP establishes rules and protocols to operate the system in accordance with Prudent Utility Practice (as defined in the T&D OMA), and as economically as possible in consideration of available electricity supply, and other system constraints. LUMA's role as the System Operator as outlined in the SOP is consistent with the legal structure and applicable regulatory requirements for the interaction between generation and the rest of the electrical system. LUMA's independence from ownership and operation of generation, as well as the System Operator's non-discriminatory dispatch of generation to satisfy reliability and economic objectives, result in tangible customer benefits. Fostering a more competitive generation sector, and implementing Puerto Rico public energy policy, including the separation of generation from other functions in the electric sector, seeks to provide greater efficiency and more effective assignment of resources resulting in a lower cost, sustainable, reliable, and resilient electric service to the people of Puerto Rico.

This System Operations Report provides an overview of how Puerto Rico's BPS has been managed since LUMA's commencement of operations on June 1, 2021 through December 31, 2022. The report provides historical data so that participants in Puerto Rico's electrical system, policymakers and customers have the required information available to make informed decisions regarding the electric system in Puerto Rico.

SOP Procedures

Prior to LUMA assuming operations of the energy system, the Puerto Rico Electric Power Authority (PREPA) had no written procedures in place to operate the BPS in a standardized manner. Although PREPA personnel had operated Puerto Rico's electric system for years with an understanding of the operational issues in the BPS, the lack of proper procedures and documentation made it impossible to ensure consistent operation under prescribed standards.

As part of our initial work leading to operation of the gird, LUMA worked closely with PREPA personnel to document how the grid was operated. This process informed the creation of 29 SOP Procedures[4] whose overall objective is to implement the SOP and allow Puerto Rico's BPS to operate reliably, consistent with

[4] The 29 SOP Procedures were prepared and submitted in final form to the Energy Bureau on December 23, 2021 in Case No. NEPR-MI-2021-0001, in compliance with the Energy Bureau's Resolution and Order of May 31, 2021.

the Contract Standards and Prudent Utility Practice, as defined in the T&D OMA. These procedures focused on topics such as system planning, operating standards, management of reserves, contingency planning, dispatch operations, outage management, and emergency response to better serve LUMA's 1.5 million customers and further the goal of ensuring the reliable and cost-effective operation of the Puerto Rico energy system. Importantly, the SOP and SOP Procedures conform with the laws of Puerto Rico, regulatory orders from the Energy Bureau, and requirements issued by various government agencies.

Given the significant legacy challenges inherited by LUMA, the main priority facing the System Operator is advancing the existing energy system to achieve minimum industry standards, while supporting compliance with the Integrated Resource Plan (IRP) Modified Action Plan, dated August 24, 2020, which includes shifting from predominantly fossil fuel-based generation to renewables and storage systems as well as energy efficiency, demand response and distributed generation. As reflected in our support for the growth and adoption of renewable energy, LUMA remains focused on improving reliability and resilience while empowering the acceleration of renewable energy in order to build the clean energy future Puerto Ricans expect and deserve.

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In 2022, as part of LUMA's overall commitment to public transparency, LUMA created a public page on its website[5] to provide accurate and timely public information about the operation of the electric system. On the webpage, customers and members of the public are able to view, in real-time, system demand, system capacity, reserves and other key indicators. LUMA also uploads a monthly report on the performance of the generating facilities operated by PREPA and private generators in terms of Available Capacity, Generation Production, and Outage Rates, among others. Understanding the performance of generation units helps the System Operator implement the economic dispatch of available units, maintain adequate reserve levels, and operate the transmission and distribution system in a safe and reliable manner.

With respect to the range of system energy demand, the Puerto Rico customer demand (or load) typically ranges between 2100 MW and 2900 MW in the summer months, and between 1800 MW to 2500 MW in the winter months. The demand peak during the period of June 1, 2021 and June 30, 2022 was 2,972 MW in June 2021, and during the period of July 1, 2022 to December 31, 2022 was 3,037 MW in August 2022.

The available capacity refers to the ratio of the maximum output of a unit available to be dispatched to the maximum potential output a unit can generate. For Fiscal Year 2022 (FY22) and the first half of Fiscal Year (FY23), the available capacity remained at 54%. As a result of issues with generation, or other events that impact energy supply, the lack of sufficient generation to meet demand can lead to load shedding to ensure the stability of the energy grid. Load shedding occurs when there is not enough energy supply (generation) to meet actual demand (load). Load shed is illustrated below when the available capacity (in orange) meets the generation demand (in blue). When load is shed, the Transmission Operations Center (TOC) intentionally reduces demand because there is not sufficient generation to meet demand, or generation cannot adjust quickly enough to maintain system technical parameters, including system frequency, to safely provide service to all customers.

[5] *System Overview*. Luma. (n.d.). https://lumapr.com/system-overview/?lang=en

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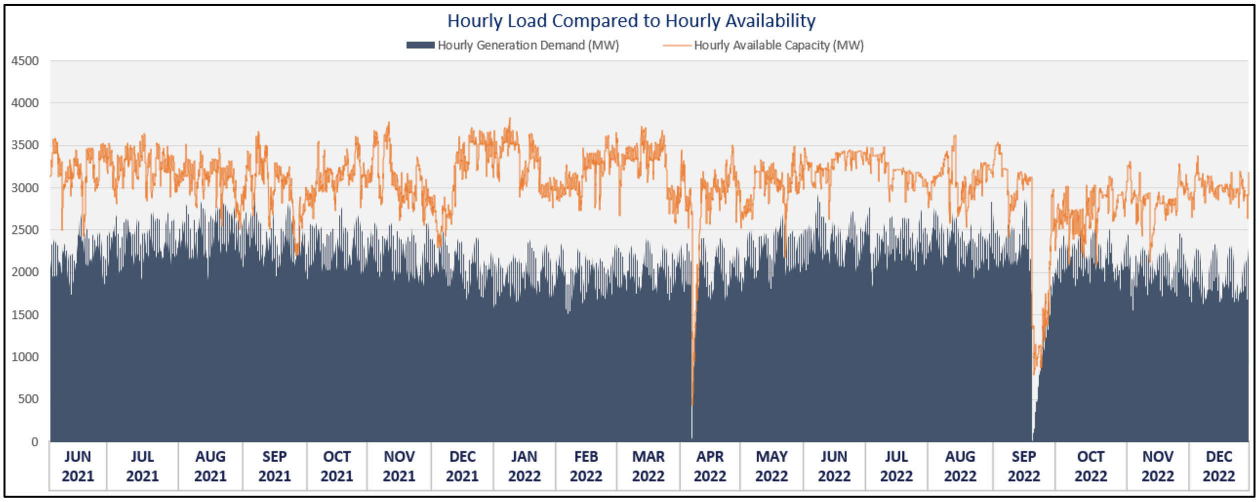
Figure ES-2 – Generation Demand Compared to Available Capacity



System reserves is the amount of generation over current demand available to meet unexpected increase in demand, or unexpected loss of generation. Per the SOP, and Prudent Utility Practice, the System Operator must keep a minimum reserves level of 750 MW. Figure 1.2 shows a heat map of the amount of reserves per hour. During the period of June 1, 2021 through December 31, 2022, the reserve requirement was met 65% of the hours.

Significant Events in 2022

Below is a summary of the significant events that affected the electrical system during 2022:

3. On April 6th, 2022, a failure in the electric system led to a fire at the Costa Sur transmission substation, which resulted in a power outage of the entire electrical system. A thorough investigation was submitted to the Energy Bureau.

4. On September 18th, 2022, a Category 1 hurricane, Hurricane Fiona, passed through Puerto Rico affecting the entire electrical system.

    a. On October 6th, 2022, LUMA submitted to the Energy Bureau a letter expressing concern with the availability of post-Hurricane Fiona dependable generation and describing the potential significant impact to customers if mitigation measures are not employed.

    b. On October 12th, 2022, the Energy Bureau ordered LUMA to prepare a stabilization plan, in coordination with PREPA and FEMA. Since then, FEMA has established the Puerto Rico Power System Stabilization Task Force who have taken the task to provide Puerto Rico with temporary generation to increase system capacity and complete repairs necessary to stabilize the system without significant service interruptions.

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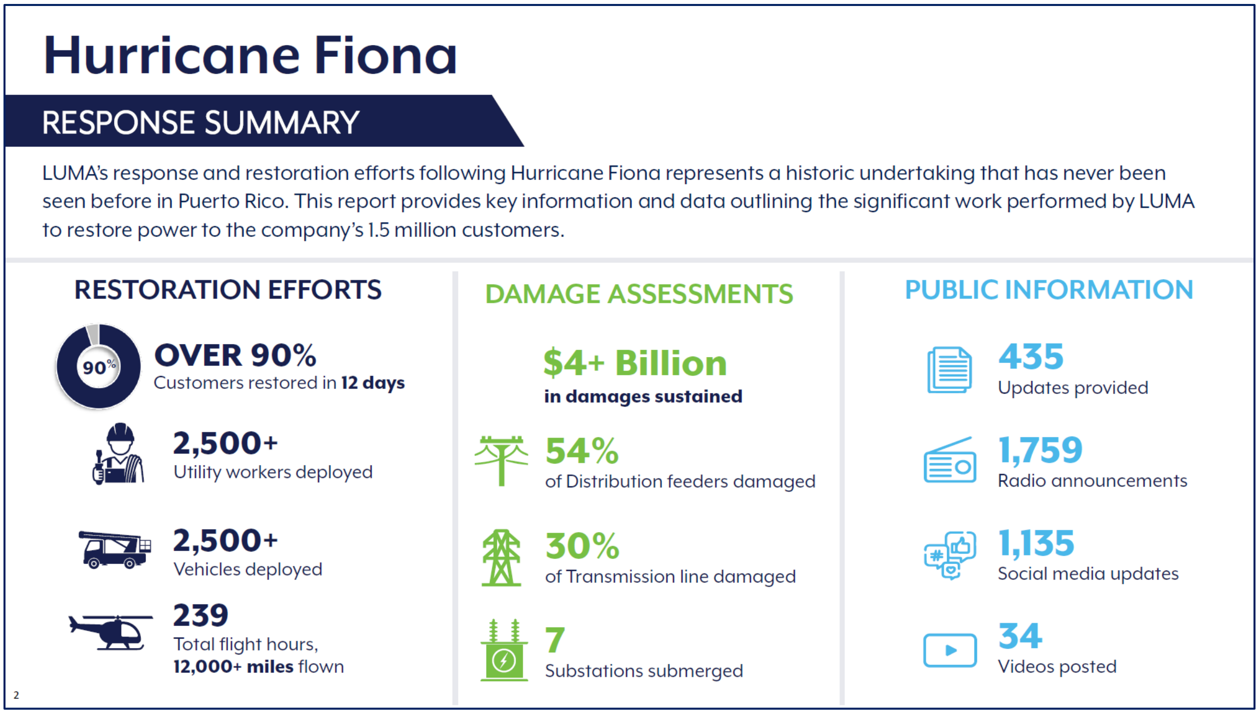
More information on these events can be found on the PREB website, where LUMA has submitted numerous reports and updates. Additionally, the public can find information on LUMA's Hurricane Fiona response and restoration efforts at lumapr.com[6].



Puerto Rico's Utility Transition from a Vertically-Integrated Model to System Operator

With the commencement of LUMA as the operator of Puerto Rico's electric transmission and distribution system and as the island's System Operator, the Puerto Rican BPS is undergoing a significant period of change to modernize and implement industry best practices. In several respects, the Puerto Rico electric system has already seen changes within a single year which have taken many other utilities many years to implement. Among the more significant changes is unbundling the Transmission and Distribution System from the Generation System. While several aspects of this transformation are still in the process of being completed, including completing the reorganization of the PREPA Generation business into a generating company (GenCo), the magnitude of changes that have been implemented is significant.

It is important to recognize that the process of unbundling vertically integrated utilities in North America and around the world typically takes many years to decades of planning and implementation. Academic and several regulatory studies have demonstrated that unbundling eventually leads to significant improvements in efficiencies which lower the total delivered cost to customers. Nevertheless, the transition itself is a challenging process which in many cases has required adjustment.

In Puerto Rico, the unbundling of the vertically integrated utility PREPA, required the development of many different policies and procedures that had never existed before. The creation of these policies and

[6] Hurricane Fiona Response and Restoration Event Summary, LUMA. https://lumapr.com/hurricane-fiona-response-and-restoration-event-summary/?lang=en

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procedures is a critical, early step. Full implementation of the behavioral changes described in these procedures will take time to fully implement. Most of the changes were implemented against a backdrop of significant generation operational disruption and load shed events that very few utilities ever face. In the coming fiscal year, LUMA, generators, and other participants in the electric system will build on these early foundational steps to institutionalize procedure compliance and documentation, increase the publication of analysis reports and operating data, and to assess performance. Continuous improvement and a drive for excellence will allow customers to more fully benefit from the unbundling transformation. Once successfully implemented, the grid will be positioned to incorporate an even greater transformation over the next several years as it moves to a carbon-free resource portfolio.

The most significant and positive operational changes made by LUMA in its first 18 months of operations are listed below. They are explained in greater detail in Appendix B. For each of these major changes, this section describes the "Inherited Conditions" which is what had existed before LUMA took over, and the "System Improvements" which describe the situation assessment that exists today.

Among the major changes made by LUMA, included are the following:

1. Developed agreements between PREPA and LUMA to separate generation assets from T&D assets including PREPA-GenCo-HydroCo Operating Agreement (PGHOA), Agreed Operating Procedures (AOP), and detailed Demarcation Plan
2. Creation of Thermal and Renewable Stakeholder Committees to provide Generator Independent Power Producers (IPPs) a forum to discuss issues and improvements with LUMA as the System Operator
3. Implemented processes and procedures to treat all generators equally and in a non-discriminatory manner
4. Introduced tools for better security-constrained economic dispatch, including programs for installation of a new Energy Management System for better visibility of the system and direct control, Automatic Generator Control so that generation units can make quick adjustments to output to maintain system operating parameters without affecting customers, and non-discriminatory decision processes for system operations
5. Improved awareness and understanding of the generation reserve required to operate the BPS in accordance with Prudent Utility Practice
6. Created the first-ever Resource Adequacy Study to quantify resource deficiencies and their impact on the BPS
7. Improved data management practices that enable data-driven decision making
8. Created new standardized policies and requirements for new generators to interconnect to the system

Since assuming operations of the Puerto Rico transmission and distribution system, and as Puerto Rico's System Operator, LUMA's over 3000 men and women have overcome significant obstacles and challenges to improve electric service. While significant progress has been made in modernizing the way the BPS is managed, efforts to fully transform the system and modernize the grid are and will continue to

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be a focus in the coming months and years. LUMA remains absolutely committed to building an energy system that operates efficiently and effectively for the benefit of the 1.5 million customers it is privileged to serve.

1.0 Electricity Demand and Generation Supply

LUMA is not responsible for the generation of electricity. In Puerto Rico, generation is owned and operated by PREPA and other private generators. LUMA, as System Operator, monitors the performance of generation on the island. Understanding the performance of the generators' units, helps the System Operator plan for the economic dispatch of available units, plan to maintain adequate reserve levels, and operate the Transmission and Distribution System following Prudent Utility Practice. The following section summarizes the performance of generation fleet, owned by PREPA and other private generators, in Puerto Rico for Fiscal Year 2022 (FY22), which ranges from June 1, 2021 to June 30, 2022, and the first half of Fiscal Year 2023 (FY23), which ranges from July 1, 2022 to December 31, 2022.

1.1 Electricity Demand

Load (or demand) represents the amount of electricity that customers are using in Puerto Rico. It is measured in megawatts (MW) and it is the energy that LUMA supplies to its customers from the generators through the transmission and distribution system. In Puerto Rico, the load will vary throughout the day, as well as throughout the year.

In the summer months, the demand will typically be between 2100 MW and 2900 MW as customers consume more energy using air conditioning units. In the winter months, the load is lower ranging from 1800 MW to 2500 MW as the weather is cooler.

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Figure 1.1 – Hourly Load Compared to Hourly Availability

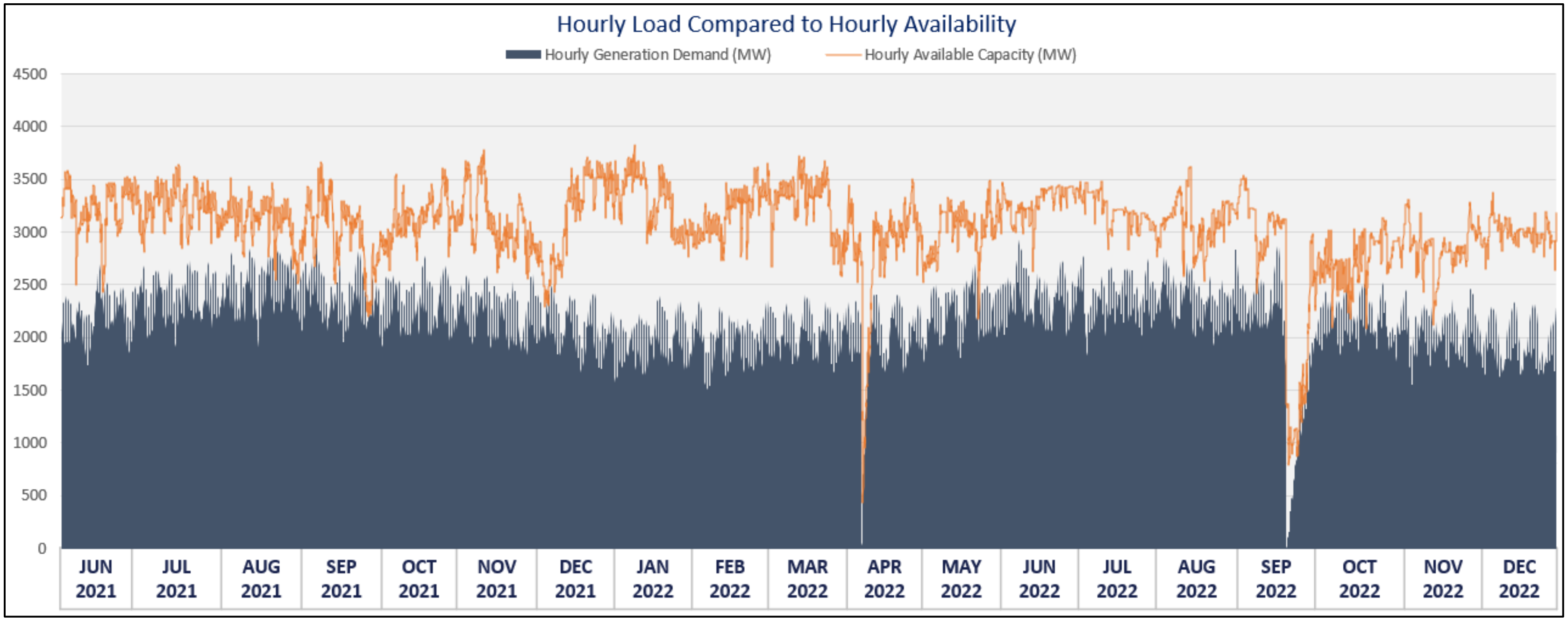

Figure 1.1: The space between the orange line and the blue shows the reserve levels which are the difference between the available generation capacity and the customer electrical demand. The hours where the orange line touches the blue are times when there was not enough generation available to meet demand. The System Operations Principles determined that the bulk power system should have at least 750 MW of reserves at every hour between the orange line and the blue lines to meet NERC Guidelines and Prudent Utility Practice.

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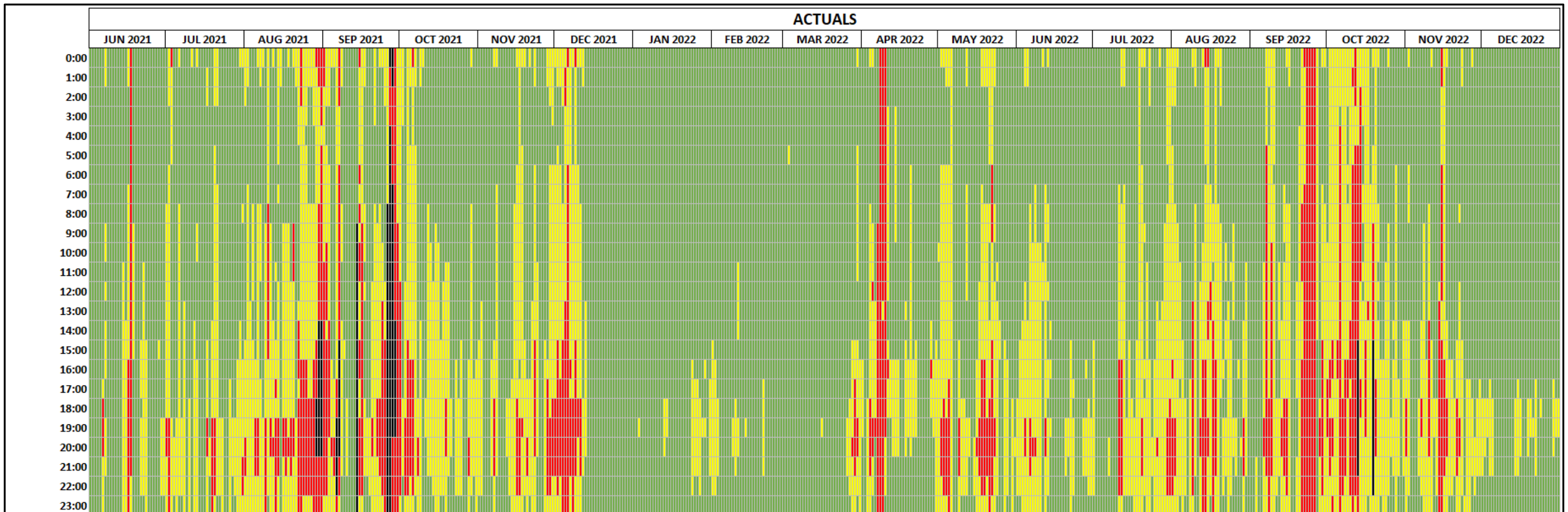
Figure 1.2 – Heat Map of Reserve Levels



	JUN 2021	JUL 2021	AUG 2021	SEP 2021	OCT 2021	NOV 2021	DEC 2021	JAN 2022	FEB 2022	MAR 2022	APR 2022	MAY 2022	JUN 2022	JUL 2022	AUG 2022	SEP 2022	OCT 2022	NOV 2022	DEC 2022
Reserves Average (MW)	997	873	631	616	808	880	1038	1292	1208	1241	858	783	907	842	777	686	599	828	1084
Hours below 750 MW	128	231	491	443	323	269	244	36	37	52	227	316	192	273	340	411	545	245	50

>750 MW	400-750 MW	<450 MW	Shortfall

Figure 1.2: This graphic shows the hourly reserve levels represented in megawatts (MW). Each cell represents one hour, each column represents one day of the month, and each row represents an hour of the day. So the entire heat map has a separate cell for each of of the 13,905 hours in the 19-month period. The green cells represent hours when there were adequate reserve levels, yellow represents inadequate reserves, red represents critical reserve deficiencies where an outage at even a small plant could result in a load shed event, and black represents generation shortfall events.

In general, the peak demand hours, from 18:00 – 22:00 (6-10 PM), show the most occurrences of critical reserve levels. In August and September of 2021, there were generation shortfall events that led to rolling blackouts throughout the Island. While the large green area from December 2021 through March 2022 indicates adequate reserves, this was a result of the winter hourly demand being approximately 1,000 MW lower than in the summer, rather than any improvement in generation availability.

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1.1.1 Customer Perspective on Generation Adequacy Issues

From June 1, 2021, to December 31, 2022, there were 80 load shed events which included planned and unplanned load shed events caused by generation shortfall or frequency imbalance; 55 load shed events in FY22 and 25 load shed events in the first half fof FY23.

Figure 1.3 depicts the days that had one or more generation events that caused a load shed event.

Figure 1.3 – Daily Demand and Load Shed Events

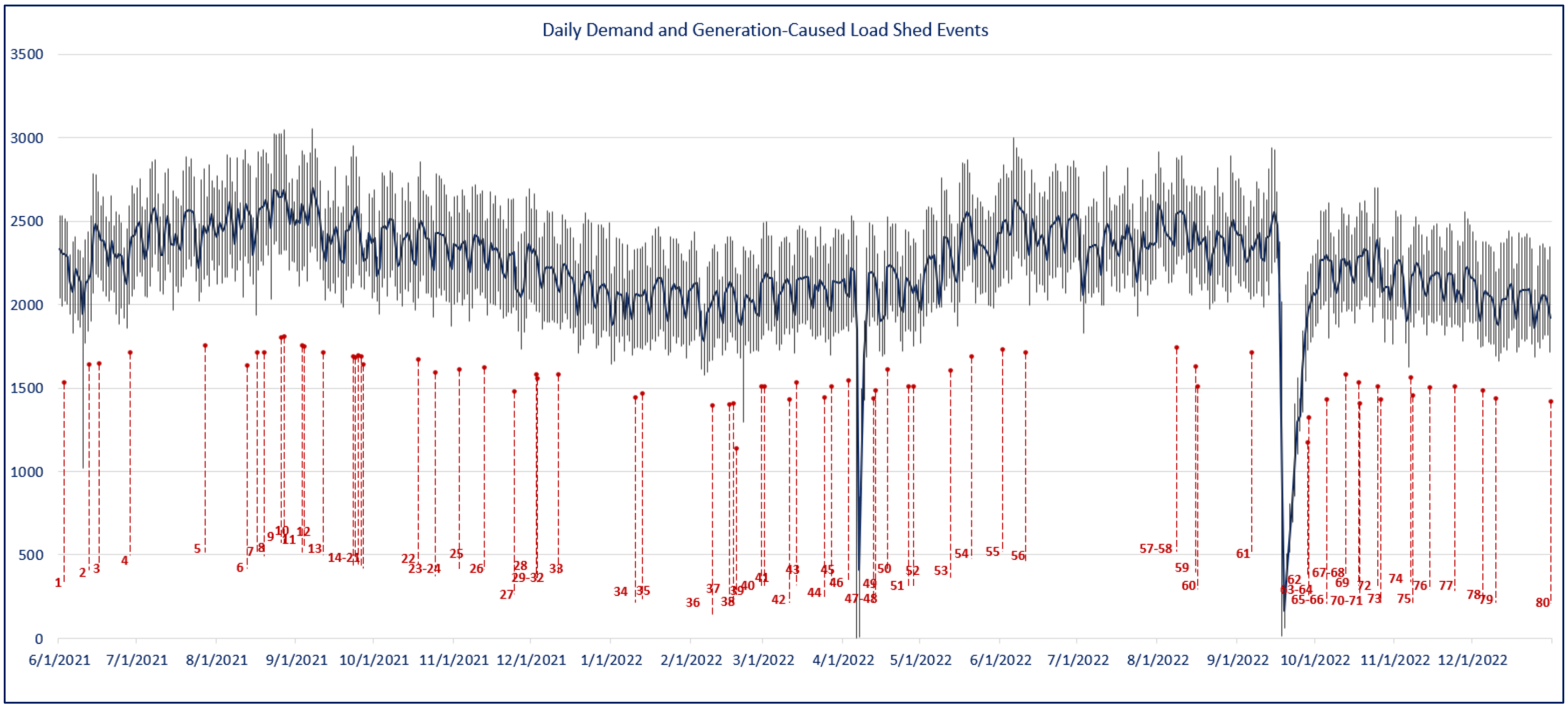

Figure 1.3**:** The gray lines in this graphic show the highest and lowest points of generation, in megawatts (MW) for each day. The dark blue line represents the average generation per day. The dashed red lines represent the days that had a load shed event (which are sequenced by the numbers at the bottom of the dashed line).

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1.2 Generation Performance

Every month, LUMA measures the performance of the various generating facilities (such as PREPA and other private generators) in terms of Available Capacity, Generation Production, Capacity Factor, and Outage Rates, among other indicators. The following exhibits show some of the trends throughout the year summarized by Thermal, Renewable, and aggregated by type of generator (baseload, peaker, solar, wind, landfill). A more detailed report on Generation Performance can be found in Appendix A.

Available Capacity

Available Capacity refers to the total available supply of electricity from the generators (PREPA and other private generators). The available capacity of each generator is determined daily by each plant and reported to the System Operator for dispatch. The generators are aggregated into Baseload and Peakers per the technology of the generating units. Below is a summary of the average available capacity per year for Fiscal Year 2022, which includes June 1, 2021 through June 30, 2022, and the first half of Fiscal Year 2023, which includes July 1, 2022 through December 31, 2022. The Availability Rate (AR) is the average megawatts (MW) of available capacity compared to the total installed nameplate capacity. The available capacity for each unit can be impacted by derates, planned outages, or forced outages.

Figure 1.4 – Average Thermal Available Capacity per Fiscal Year

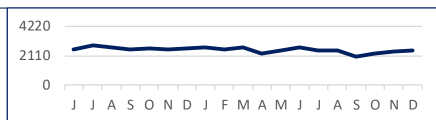
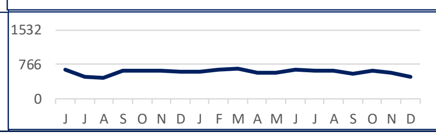
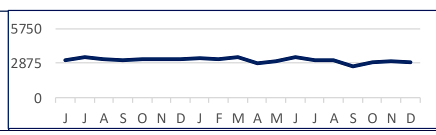
	Available Capacity (MW) and Availability Rate (AR)		FY22	FY23
Total Baseload Nameplate Cap: 4220		MW	2601	2366
		AR	62%	56%
Total Peakers Nameplate Cap: 1531		MW	601	589
		AR	39%	39%
Total System Nameplate Cap: 5751		MW	3202	2956
		AR	56%	51%

Figure 1.4: This graphic shows the average available capacity per Fiscal Year. The first line aggregates all baseload thermal units from PREPA and other private generators (Total Baseload). The second line aggregates all thermal peaking units from PREPA's facilities (Total Peakers). The third line shows the average available capacity for the Total System, considering only thermal units. The Availability Rate (AR) is shown for each month and represents the average megawatts (MW) of available capacity (blue line) compared to the total installed nameplate capacity (green line). The nameplate capacity is the maximum rated output of a generator.

Thermal Generation

Thermal generation is categorized into baseload generation and peaking generation. Baseload generation represents the electricity that was generated by PREPA and other generators' thermal power plants. These thermal plants produce electricity least expensively. To avoid impacting customer rates by using expensive fuels to generate electricity, PREPA and other generators try to operate these units as

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many hours per month as they are available. Peaker generation represents the electric output of PREPA's thermal peaking power plants, PREPA's Aguirre Combined Cycle, and the aggregation of all of PREPA's small gas turbines. These thermal peaking plants are significantly more expensive than baseload plants and are operated only when required. The Capacity Factor is the percentage of generation, expressed in megawatts (MW), out of the total installed nameplate capacity.

Figure 1.5 – Average Thermal Generation per Fiscal Year

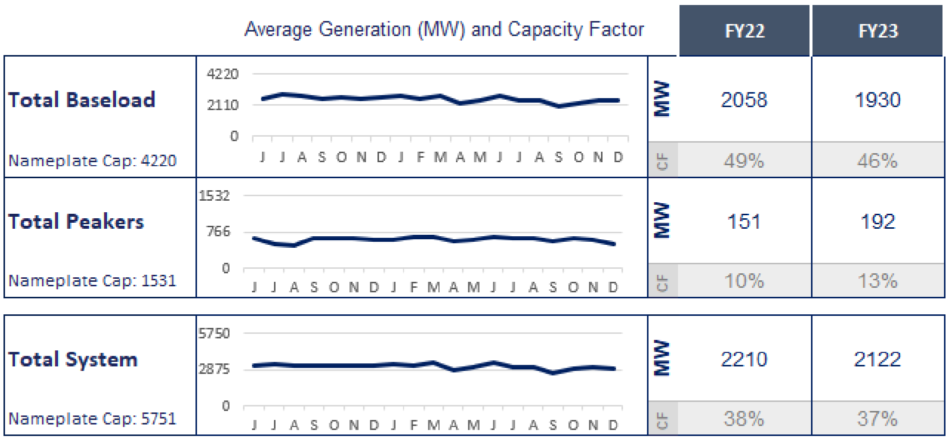

Figure 1.5: This graphic shows the average generation per Fiscal Year. The first line aggregates all baseload thermal units from PREPA and other private generators (Total Baseload). The second line aggregates all thermal peaking units from PREPA's facilities (Total Peakers). The third line shows the average generation for the Total System, considering only thermal units. The Capacity Factor (CF) is shown for each month.

Renewable Production

The renewable IPPs in Puerto Rico are comprised of four technologies: Solar, Wind, Landfill Gas, and Hydroelectric. The derived capacity factor of the weighted average portfolio mix for Fiscal Year 2022 is 17%, and 14% for the first half of Fiscal Year 2023. The capacity factor is a function of the 24-hour efficiency of a generator in producing electricity at its maximum output capacity.

While Puerto Rico has a very good solar resource, its high winds during hurricane season have historically led to the installation of utility-scale solar facilities on fixed-tilt structures to increase their mechanical strength against high winds. Additionally, it must be considered that solar panel degradation of approximately 0.5% annually shall degrade the capacity factor of solar arrays over time. Finally, it is understood that capacity factors can vary approximately 10% from year to year depending on local weather conditions in any given year.

The wind resource in Puerto Rico is highly correlated to the solar resource, meaning that it follows a daytime production curve similar to that of solar PV. Wind resources also demonstrate a year-on-year variability depending on weather patterns.

The landfill gas installations in Puerto Rico are dependent on the amount of gas generated by the landfill matter. Puerto Rico landfills are not required to separate organic and non-organic materials, and this mix

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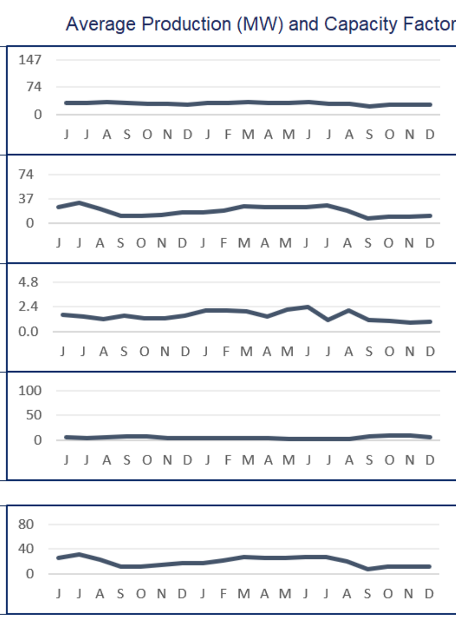
of waste produces a relatively lower quality of constant gas production relative to jurisdictions that separate their waste.

Finally, the hydroelectric facilities in Puerto Rico are operated by PREPA. The generation that these facilities produce is dependent upon the reservoir levels, sediment levels, the prioritization in delivery of raw water to the Puerto Rico Aqueduct and Sewer Authority (PRASA) or for agricultural deliveries, and other operational conditions. Additionally, only four out of the ten hydroelectric plants are currently active, which account for about 38.5 MW of installed capacity. Most plants have been out of service due to damages from previous hurricanes (Georges in 1998 and Maria in 2017).

Figure 1.6 – Average Renewable Production per Fiscal Year



		FY22	FY23
Total Solar Nameplate Cap: 147	MW	31	26
	CF	21%	18%
Total Wind Nameplate Cap: 75	MW	20	14
	CF	26%	18%
Total Landfill Nameplate Cap: 4.8	MW	2	1
	CF	35%	25%
Total Hydro Nameplate Cap: 99.7	MW	4	6
	CF	4%	6%
Total Renewables Nameplate Cap: 326.6	MW	56	47
	CF	17%	14%

Figure 1.6: This graphic shows the average yearly production of the interconnected renewable projects from June 1, 2021, through December 31, 2022, which includes Fiscal Year 2022 and the first half of Fiscal Year 2023. The Capacity Factor (CF) is shown for each month, and represents the percentage of production, expressed in megawatts (MW), out of the total installed capacity.

2.0 Fuel Price Variability and History

As stated previously, it is important to note that LUMA is not responsible for the generation of electricity, fuel costs, and has no control over the impact fuel costs have had—and may continue to have—on customer rates. Global fuel prices showed historic levels of volatility in the period from 2020 to 2022, from the global decline in demand during the COVID-19 pandemic lockdowns, through post-pandemic demand increases, to market uncertainty, supply restrictions due to the war between Russia & Ukraine, and macroeconomic headwinds. This section provides an overview of the global markets and their impact on customers. Since taking over operations of the transmission and distribution system, LUMA did not raise or propose increasing customer rates. Rate increases experienced by our 1.5 million customers were solely related to generation fuel costs.

2.1 Fossil Fuel Market

2.1.1 Global Economy Recovering from COVID-19 Pandemic

The fossil fuel industry was significantly impacted due to the COVID-19 Pandemic. Global-wide lockdowns were enforced, and demand for crude oil and its derivatives naturally declined. Lower demand caused supply cuts, which translated into lower fuel prices overall. The monthly average spot price of crude oil in the US (WTI) fell to as low as $16.55 per barrel (bbl) in April 2020. The liquefied natural gas (LNG) market was equally impacted for the same reasons. The monthly average spot price of natural gas in the US (Henry Hub) shared a similar trajectory as the WTI, falling to as low as $1.74 per million British thermal units (MMBtu) in the same month. Price movement on crude oil and natural gas have historically shared a strong correlation.

As the effects of the pandemic started to ease, so did the severe measures to mitigate it. Looser restrictions caused demand to rebound and paved the way for the global economy to start recovering from all the adversities that the pandemic imposed. Fast forward to January 2021, the monthly average WTI spot price stabilized to approximately $52/Bbl, while the monthly Henry Hub spot price averaged $2.71/MMBtu.

The year 2021 saw fuel prices increase beyond pre-pandemic levels. This can be mainly attributed to global demand for crude and LNG rising faster than supply. Petroleum production globally increased slower than demand, mostly attributed to crude production cuts from OPEC in 2020 to increase prices when they were at their lowest point. In addition, the United States saw exploration and production levels fall as a result of increased investor pressure to maintain profit and dividend levels for the major oil companies. In terms of LNG, demand growth outpaced production growth as high levels of exports from the US kept inventory levels below average. This demand-supply imbalance caused fuel prices to soar in the short term as the economy rebounded from the Covid pandemic.

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Figure 2.1 – Fuel Price Indices

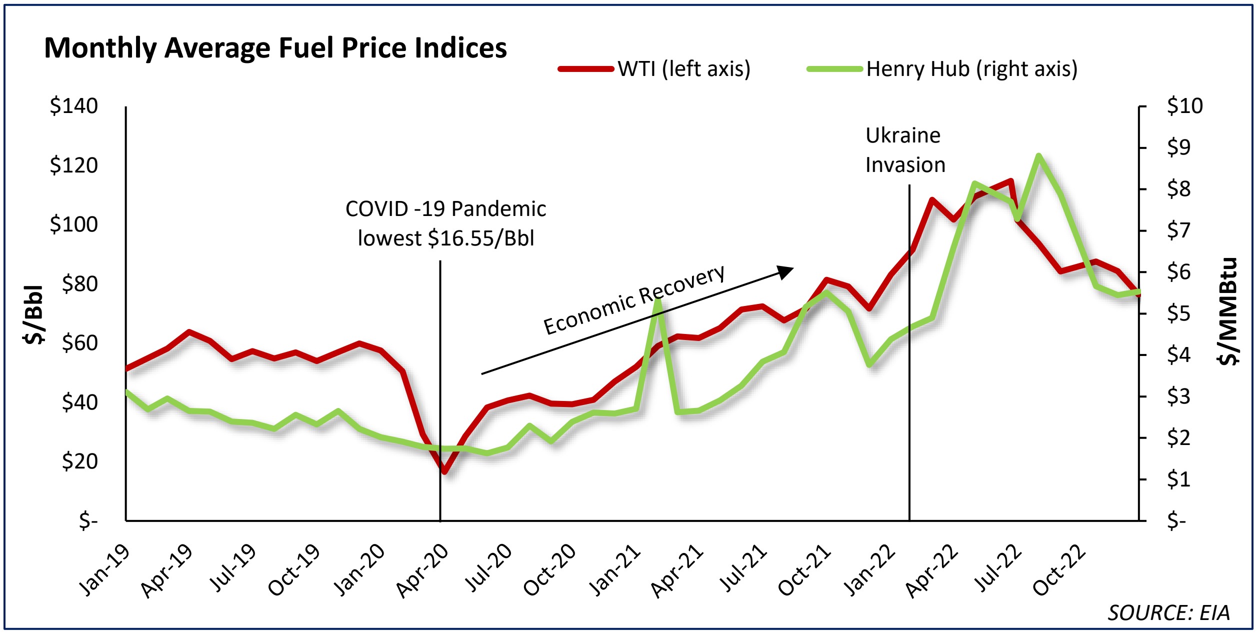

Figure 2.1: This graph shows the monthly average price of Cushing, OK WTI (Western Texas Intermediate) Spot Price FOB (Dollars per Barrel), which serves as one of the main global oil benchmarks, and the Henry Hub Natural Gas Spot Price (Dollars per Million Btu), which serves as the main LNG benchmark in the US, as per the U.S. Energy Information Administration (EIA).

2.1.2 Russo-Ukrainian War and Supply Chain Disruptions

The average price of crude oil (WTI) rose 58% Year-over-Year (YoY), from $72/Bbl in June 2021 to $115/Bbl in June 2022. Much of this price increase was provoked by Russia's invasion of Ukraine that began in February 2022. Russia is one of the biggest producers of crude oil and natural gas in the world, and although oil prices were rising before the invasion, the Russo-Ukrainian war conflicts created a series of unforeseen challenges that shook the energy industry, including but not limited to shortages in fuel deliveries to Europe as a result of economic sanctions on Russian imports to Europe. One of the many adverse effects of this war was the skyrocketing increase in fuel prices and all commodities prices as traders speculated on what the long-term impacts would be.

As a result of the invasion, the global community imposed a series of economic sanctions, including the ban on Russian oil and gas exports to Europe. This created a bottleneck effect that caused fuel prices to increase dramatically in the short term as Europe attempted to build LNG inventories to prepare for the winter of 2022 to replace Russian pipeline supplies. International relations, geopolitics and foreign policies had a major role to play in the increase of fuel prices. The increase in crude oil price resulted in the record-high price of gasoline in the US, which was the biggest contributor to the Consumer Price Index of 9.1% YoY in June 2022, the highest in over 40 years.

The global LNG markets saw an even steeper increase than crude oil as a result of the war. The average spot price of the Henry Hub rose 101% YoY, from $3.84/MMBtu in June 2021 to $7.70/MMBtu in June 2022. This market was structurally tight before the Russian invasion of Ukraine and is now even tighter as

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U.S. producers increased LNG exports to Europe. Ban of exported Russian LNG meant a decrease and ultimately a complete shutdown of LNG coming from Russia to Europe, rapidly creating a supply shortfall.

Several factors had key roles to play in the rise of prices of LNG in the US in 2022. The main contributor would be the strong demand for LNG created from constraints in supply in Europe and Asia, resulting in increased levels of LNG exports from the U.S. Another is the colder-than-normal temperatures in the first quarter of 2022, resulting in above-average consumption. As domestic consumption and exports grew, inventory levels lowered, and demand outpaced production; the Henry Hub rose to a 12-month high at $8.17/MMBtu, which sharply declined quickly in the following month due to an outage at the Freeport LNG export terminal. The export terminal's shutdown meant that all of this supply would be available for domestic demand, lowering the overall cost of the Henry Hub.

Shortly after LNG prices peaked in the 2nd half of 2022, most speculation of supply bottlenecks created from the Russo-Ukranian war faded quickly. Lower consumption from unseasonably mild weather and substantial inventories of LNG amassed over the year in Europe meant a supply-demand imbalance, diminishing the reality of a shortfall in the near term. Afterwards, Europe was successful at reducing their reliance on Russian LNG by finding other suitable sources for their supply needs, including exports from the US, which reached record-highs in 2022.These drivers helped eliminate almost completely the huge spike LNG prices in the 1st half of 2022. A similar supply-demand imbalance happened in the US, which resulted in immense downwards pressure in the price of the Henry Hub.

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2.2 Impact to Customers

2.2.1 PREPA Fuel Purchase

PREPA's fuel purchase contracts are exposed to fossil fuel markets. Trends in what PREPA pays for fuel will directly reflect trends in the fuel market. Because of the nature of the individual fuel contracts and how they are priced, the majority of PREPA fuel purchases can be considered spot prices.

Figure 2.2 –Average Delivered Fuel Price in Puerto Rico by Type

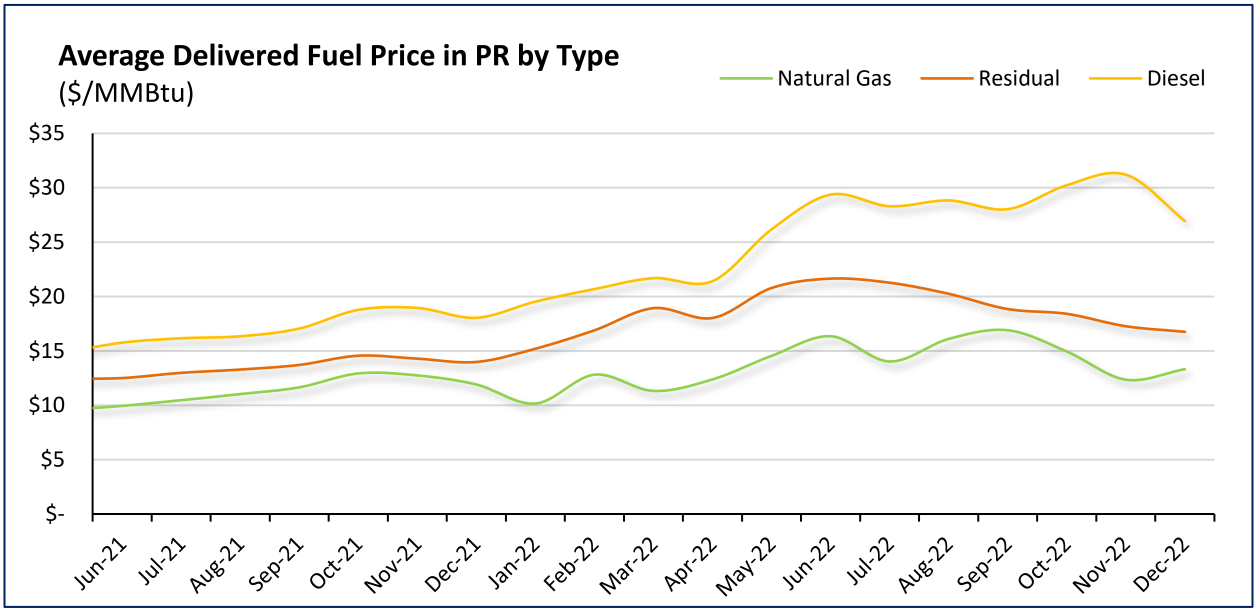

Figure 2.2: This graph shows the average delivered fuel price in Puerto Rico by type. The types of fuel that PREPA purchases are LNG, Residual (Bunker C) and Diesel.

Higher fuel prices will lead to higher fuel expenditures. In June 2022, PREPA was paying close to three (3) times more for fuel than what they paid in October 2020 (~$100MM vs ~$280MM). Most of the increase in fuel expenditures is attributed to higher fuel prices, although supply-side problems like fuel delivery, available capacity, operational reserves, and unplanned changes to the outage schedule had roles to play as well. These variables will all affect the distribution of fuel consumption throughout the whole fleet, in instances replacing cheaper fuel with more expensive ones.

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Figure 2.3 – Fuel Expenditures by Type

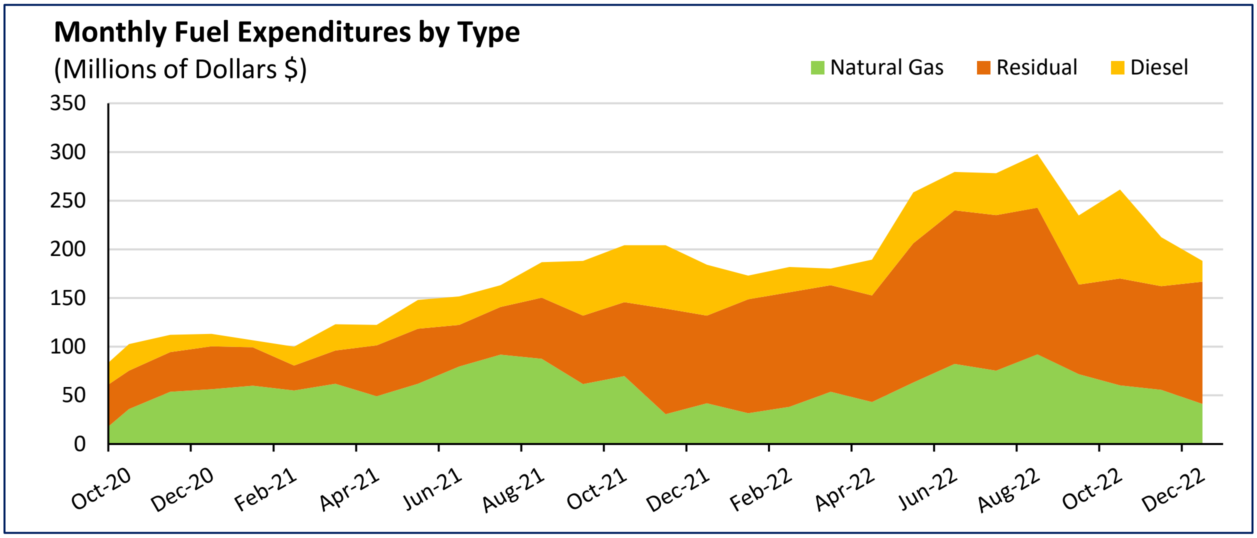

Figure 2.3: This graph shows how much PREPA has paid for fuel for the past 2 years by fuel type. The trend in total fuel expenditures is correlated to the trend in fuel prices. At times, PREPA consumes more diesel fuel to compensate for out-of-service baseload plants. When this increased diesel consumption coincides with elevated prices, there is a significant increase in the total dollar cost to consumers.

Figure 2.4 – Distribution of Fuel Consumption

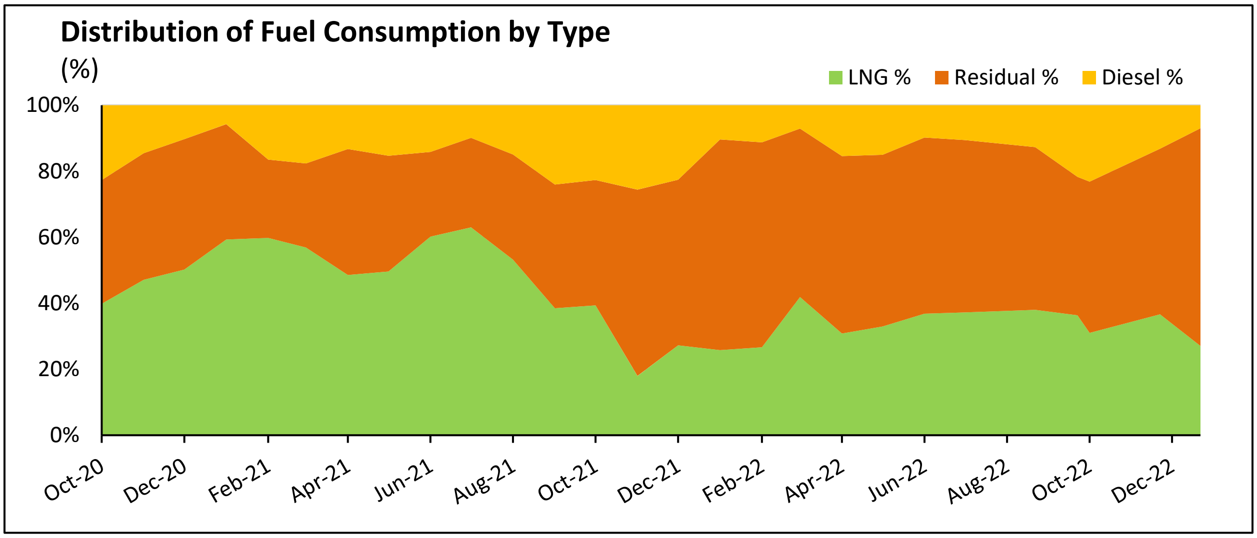

Figure 2.4: This graphic shows the distribution of fuel consumption by fuel type. In October 2021, Costa Sur started using a mixture of Residual and LNG to generate energy. The LNG provider was unable to deliver the nominated quantities of fuel, due to what they claim were operational problems on their end. This caused the variable cost of producing energy of the plant to increase, the share of Residual consumption to displace a considerable portion of the LNG consumption, and ultimately increased total fuel expenditures. To this day, Costa Sur is burning more than half of its fuel using Residual.

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Figure 2.5 – Average Fuel Costs by Plant Type

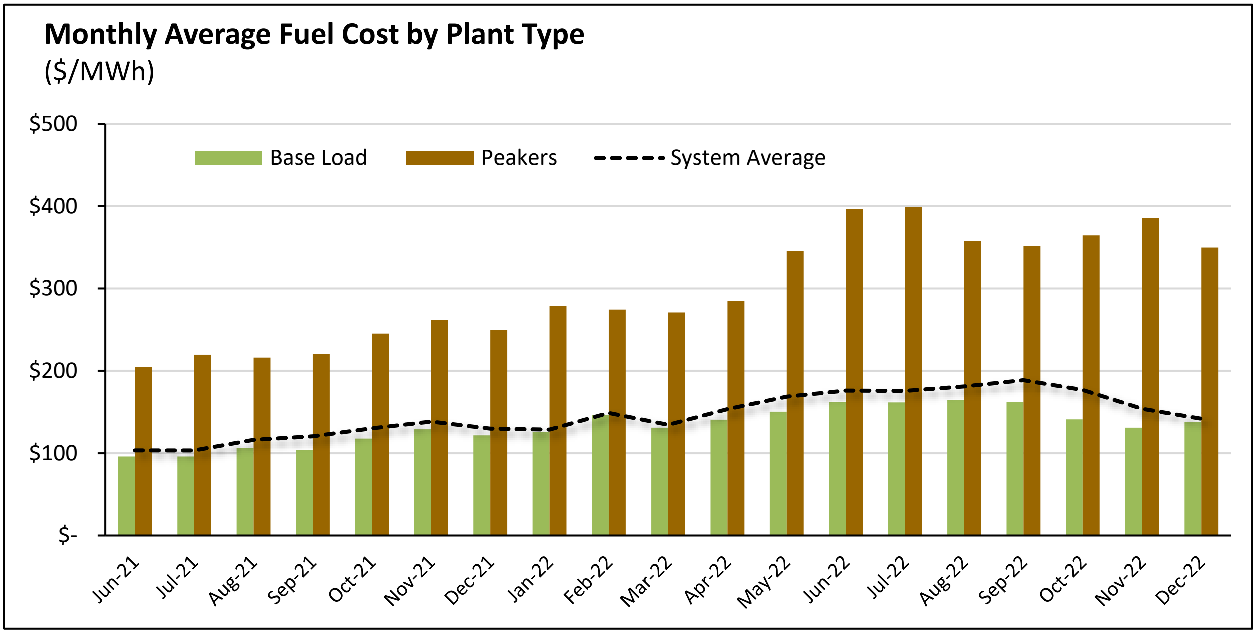

Figure 2.5: This bar chart shows the average fuel cost by Baseload, Peakers, and the System Average in terms of dollars per Megawatt hour. This chart considers only thermal generators, as renewables and hydro are not included. As fuel prices and fuel expenditures increase or decrease, so will the overall price of producing energy.

Figure 2.6 – Average Fuel Costs by Plant

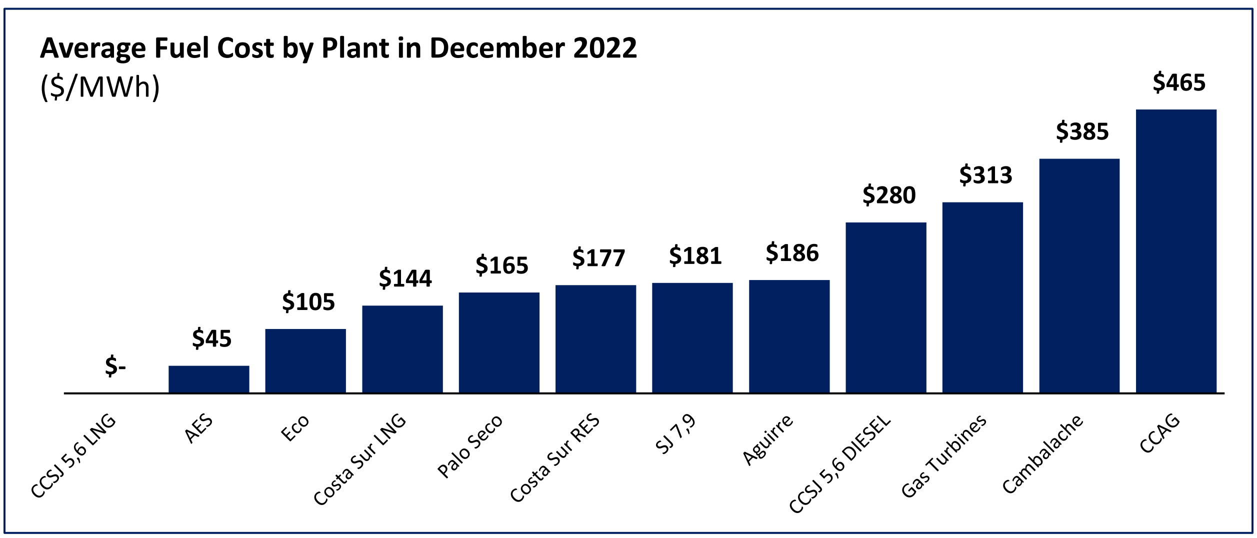

Figure 2.6: This chart shows the average fuel cost by plant for December 2022. AES considers only the coal purchase from the PPOA and is included to reflect the variable cost of producing energy.

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2.2.2 Fuel Charge Adjustment (FCA)

PREPA's fuel costs are reconciled on a quarterly basis and are a function of forecasted kWh sales (expected energy that customers will consume), forecasted fuel costs, and the over- or under-collections from the previous quarter. The reconciliation of these costs are adjusted through a rider in the customer bill called the Fuel Charge Adjustment (FCA) and passed on to customers. This pass-through mechanism allows the Energy Bureau to regularly adjust the price of electricity to reflect any fluctuations in the price of the fuel itself. Fuel costs make up a hefty portion of the cost of electric generation and can fluctuate over short periods; the FCA allows for recovery of the impact of fuel price fluctuations as they occur to avoid these balances building up to levels that would threaten the utility's balance sheet and the financial sustainability of the electric sector. LUMA has no control over the cost of fuel used for generation and does not determine the impact on customer rates. The PREB determines the rates customers pay for electricity. LUMA does not financially benefit or profit from any change or increase in generation fuel costs.

2.2.3 Gasoline Prices at the Pump

A good and easy-to-understand reference to show that the utility has no control over fluctuations in the fuel market is the price of gasoline at the pumps. The price of gasoline moves very similarly to the price of crude oil and to the unit fuel price that PREPA pays. All of these refined fuel products and derivatives are highly dependent on the price of crude oil.

Figure 2.7 – Gasoline Price in Puerto Rico

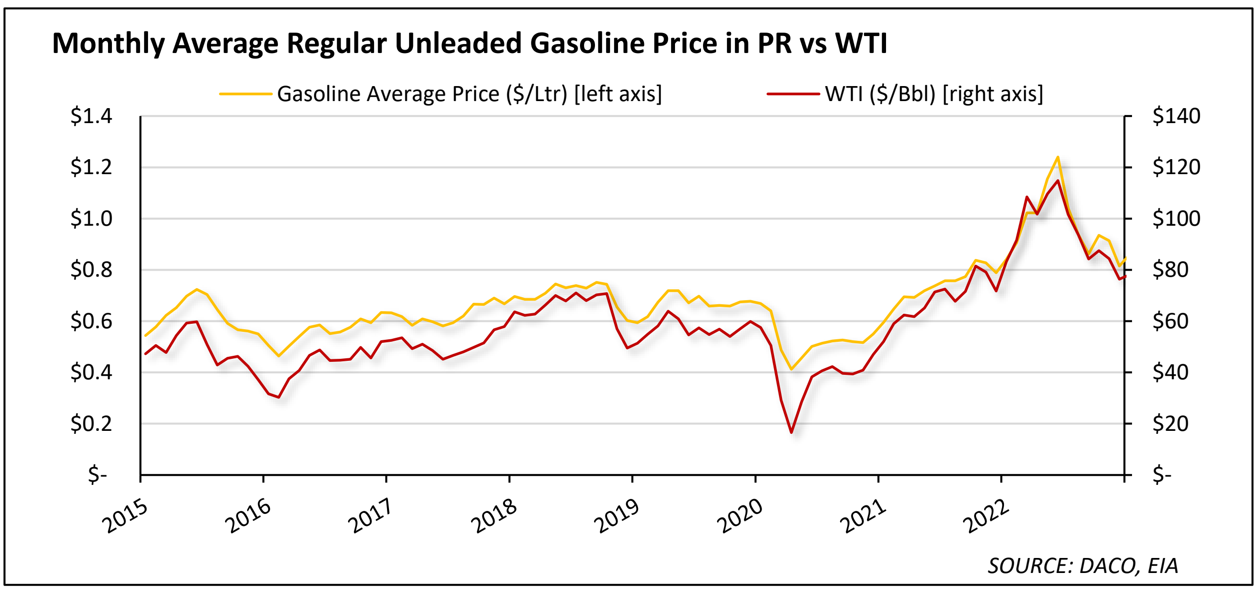

Figure 2.7: This graph illustrates the strong correlation between the average price of regular unleaded gasoline in Puerto Rico, and the OK WTI (Western Texas Intermediate) Spot Price FOB (Dollars per Barrel), per the Puerto Rico Department of Consumer Affaris (DACO) and the U.S. Energy Information Administration (EIA).

2.2.4 Perspective on Other Energy Markets

The surge in electricity costs during recent years was not unique to Puerto Rico. Around the world, countries that are dependent on fossil fuels as an energy source and not rich in reserves saw drastic increases in electricity prices. The regions of the world that have been most affected this past year have been Europe and Asia. For example, the Dutch TTF, which is the benchmark indicator for LNG prices in most of Europe, spiked to $70/MMBtu in August 2022, compared to the $8.81/MMBtu Henry Hub peak in May of the same year. This resulted in significant disruptions to global fuel patterns as LNG that is produced in Trinidad was redirected to Europe, and much of the global LNG that was heading to China was redirected to the Japan-Korea market since Chinese demand was dramatically reduced due to their extended Covid lock-downs.

Figure 2.8 – Comparative LNG Prices in Different Markets

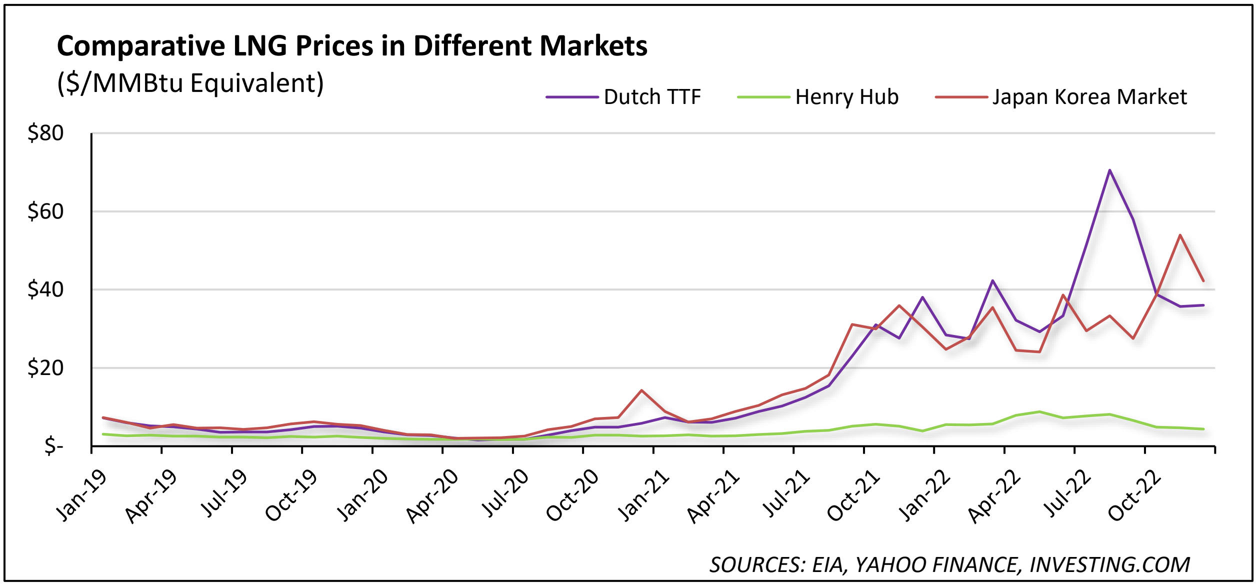

Figure 2.8: This graph shows the monthly average prices for the Henry Hub Natural Gas Spot Price, the Dutch TTF Gas Futures, and the LNG Japan/Korea Marker PLATTS Futures, as per th U.S. Energy Information Administration (EIA), Yahoo Finance and Investing.com.

3.0 Capacity Additions and Withdrawals

Act 17-2019 ("Act 17") defines the Integrated Resource Plan (IRP) as a plan that considers all reasonable resources to satisfy the demand for electric power services during a specific period, including those related to energy supply, whether existing, traditional, and/or new resources, and those related to energy demand, such as energy conservation and efficiency, demand response (DR), and distributed generation (DG) by industrial, commercial, or residential customers. On February 13, 2019, PREPA filed the IRP according to the Puerto Rico Energy Bureau's Resolution and Order of March 15, 2018, in docket CEPR-AP-2018-0001. By Resolution and Order of August 24, 2020, the Energy Bureau approved in part and rejected in part PREPA's proposed IRP and approved a Modified IRP and a Modified Action Plan. The Modified Action Plan includes a combination of transmission system hardening and distributed resource deployment to ensure a resilient power system, in addition to distribution system hardening.

3.1 New Renewable Resources and Battery Storage

Act 17 was built upon the foundation created for integrated resource planning in Act 57 and sharpened the focus on accelerated renewable energy provision, energy conservation and efficiency, and distributed resources. In so doing, Act 17 increased the renewable portfolio to a minimum of twenty percent (20%) by 2022, forty percent (40%) by 2025, sixty percent (60%) by 2040 and one hundred percent (100%) by 2050 and created an energy efficiency target of thirty percent (30%) by 2040. Act 17 also emphasizes the role of the "prosumer" generation and envisions an enhanced role for microgrids.

Tranche 1 was initially issued by PREPA in February of 2021, seeking 1000 MW of renewable generation, 500 MW of 2-4-hour storage, and a VPP resource provider. During the RFP process, LUMA has performed Interconnection Studies (Feasibility, Facility, and System Impact) for the short-listed projects as determined by PREPA and the Energy Bureau, as well as providing operational comments to the commercial contracts between PREPA and Resource Providers. As of 12/31/22, LUMA has performed Interconnection Studies on 18 solar projects and 9 BESS projects. There are currently 844 MW of new generation contracts executed and 220 MW of Energy Storage. In addition, there is a single, 17 MW VPP approved by the PREPA Governing Board[7]. Once closing conditions are met, executed contracts are expected to reach their Commercial Operation Date in 24 months.

In September 2022, the Energy Bureau issued the first draft of the Tranche 2 procurement process. Tranche 2 seeks an additional 1000 MW of renewable generation, 500 MW of storage, as well as Virtual Power Plant resources. Since then, the Tranche 2 bid process has proceeded to the interconnection study phase. Feasibility, POI Facility, System Impact and Network Upgrade Facility Studies will be performed by LUMA.

3.2 Thermal Resources

The Modified Action Plan considered the retirement of the oil-fired steam resources during the years 2019-2025. The plan includes retiring San Juan units 7, 8, 9, and 10; at Palo Seco, units 3 and 4; and at Aguirre, units 1 and 2. Additionally, the Modified Action Plan considers the retirement of Aguirre Combined

[7] The Energy Bureau approved the final Grid Services Agreeent for this VPP by Resolution and Order of December 19, 2022, in Case No. NEPR-MI-2020-0012.

Cycle (CC) units 1 and 2. These units would be retired based on the installation schedule and location of any new peaking generation, solar PV, and energy storage resources, and only after new resources are fully operational. As of June 30, 2022, the status of these units is as listed below.

Table 3.1 – Status of Units to be Retired per the Modified Action Plan of 2018

Unit	Service Status (as of Dec 31, 2022)	Comments
San Juan 7	In Service	
San Juan 8	Out-of-Service (June 17, 2021 – June 30, 2022)	Will be out of service through 2023.
San Juan 9	In Service	
San Juan 10	Out-of-Service (March 13, 2016 – June 30, 2022)	Will be out of Service through 2023.
Palo Seco 3	In Service	
Palo Seco 4	In Service	
Aguirre 1	In Service	
Aguirre 2	In Service	
Aguirre CC 1	In Service	
Aguirre CC 2	In Service	Steam unit out of service since June 28, 2017. Combustion units 2-1 and 2-2 out of service since July 14, 2005, and September 27, 2016, respectively.

As approved by the Energy Bureau in the Modified Action Plan, the retirement of these units is contingent on the procurement and installation of new generation. As of December 31, 2022, no new resources were installed.

4.0 Bulk Power System Performance

In addressing an improved Bulk Power System (BPS), LUMA has established a comprehensive capital investment program, focused on both the transmission system and transmission substations, the intent of which is to address aging/deteriorated infrastructure, improve reliability, and increase safety and security, while ensuring compliance with governing regulations and/or Prudent Utility Practice.

These programs, including the Transmission Line Rebuild, Transmission Priority Pole Replacements, Transmission Substation Rebuild, and Transmission Substation Reliability Improvements, are specifically targeted at producing consistent and sustainable improvement in reliabililty and overall electricity service to customers.

Every quarter, LUMA is responsible for submitting to the Energy Bureau a report on system data and metrics as the result of the Resolution and Order of May 14, 2019 in docket no. NEPR-MI-2019-0007 (as subsequently modified or clarified). Such metrics include:

- Safety Metrics
- Finance Metrics
- System Reliability
- Customer Service
- Renewable Energy and Demand Side Management Metrics

4.1 Transmission Portfolio

The Transmission portfolio focused on improving system recovery, resilience, and transformation. It consists of three programs: Information Technology (IT) and Operational Technology (OT) Telecom Systems and Network, Transmission Line Rebuild, and Transmission Priority Replacement:

Table 4.1 – Transmission Portfolio Summary

Program Title	Purpose	FY2022 Activities
IT OT Telecom Systems and Network	Improve and revamp the systems used to carry T&D system IT and OT data	• Defined scope of technical and procurement specifications for major programs (e.g., Transport Network, Microwave, and Land-Mobile Radio) • Completed/ published engineering specifications for towers, fiber optic, OSP, substation and telecom enclosures
Transmission Line Rebuild	Rebuild, harden, and upgrade the transmission infrastructure	• Prepared function specifications for 42 transmission line rebuild projects • Obtained the Energy Bureau's approval and initiated FEMA approval process for 38 transmission line rebuild projects • Submitted an initial "test case" detailed Scope of Work (SOW) to FEMA for one project

Program Title	Purpose	FY2022 Activities
Transmission Priority Pole Replacement	Replace damaged overhead transmission poles and towers (including associated hardware and conductors)	• Conducted high-level assessments of 284 transmission lines (including all of the 230kV and 115kV systems) • Completed five detailed SOWs which have been submitted to FEMA for approval

In addition to the activities performed within this portfolio of programs, LUMA laid the groundwork for aerial inspections (as a supplement to the high-level assessments) incorporating the latest technology in conducting infra-red, corona, and visual inspections.

4.2 Substation Portfolio

The transmission portion of the substation portfolio, aimed at improving system resiliency and safety while rebuilding, hardening, and modernizing substations, consists of four programs: Transmission Substation Rebuild, Transmission Substation Reliability Improvement, Transmission Substation Security, and portions of Compliance and Studies:

Table 4.2 - Substation Portfolio Summary

Program Title	Purpose	FY2022 Activities
Transmission Substation Rebuild	Address the required assessment, repair and rebuilding of damaged substations while making upgrades to meet the latest codes, industry standards and practices to improve long-term reliability	• Completed planning analysis activities • Developed functional specifications/ conducted field assessments for 18 substations • Submitted seven projects to FEMA, of which FEMA funding obligations for three were received
Transmission Substation Reliability Improvement	Upgrade and reinforce the existing and aging system infrastructure to improve system reliability	• Conducted high-level assessments for 113 substation sites • Developed plans to replace aging high-voltage infrastructures that were deemed end-of-life or received poor condition assessment ratings
Transmission Substation Security	Improve security at transmission substations, targeting replacement and addition of new security technology and hardware to deter, detect and delay security incidents.	• Replaced substation gate padlocks with a key control process • Performed two rounds of preventative vegetation control activities at critical substations • Submitted three detailed SOWs and class 3 estimates (addressing 10 substations) to FEMA for review and approval

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Program Title	Purpose	FY2022 Activities
Compliance and Studies	Conduct T&D system studies to (1) eliminate major cascading outages caused by a lack of proper coordination of protective devices, (2) implement new procedures and standards to ensure that the system complies with regulations and Prudent Utility Practice; and (3) complete studies, procedures and standards for substations and transmission compliance	• For Wide Area Protection –230kV work orders were sent to the field with115kV work orders still under development • Performed NERC TPL-001-4 and NERC CIP-014-2 standard studies to determine (1) major issues with the transmission system and (2) measures to achieve a secure and more reliable system • Developed a steady-state transmission network model to perform system-level analyses (including contingency, load transfer, renewable interconnection and system risk studies) • Performed transmission load evaluations for 28 projects

In addition to the activities performed within this portfolio of programs, LUMA implemented a substation maintenance program, initially addressing the 23 most critical substations with a focus on high-voltage transformers and breakers while reducing the number of substations out-of-service from 28 to 21. A risk-based analysis was performed to prioritize projects and investments, that considered source and load, transmission line priority, generation, connections, square of the age as a proxy for condition, bus configuration, and transformer redundancy.

5.0 Resource Adequacy

The Resource Adequacy Study assesses the sufficiency of electricity generation owned and operated by the Puerto Rico Electric Power Authority (PREPA) and other generators to meet existing electric customer load requirements in Puerto Rico by evaluating the risk of loss load during the next 12 months. LUMA, which does not generate electricity, carried out this analysis in compliance with its responsibilities under the T&D OMA to inform the Puerto Rico Energy Bureau, policymakers and stakeholders about the adequacy and inadequacy of generation resources in Puerto Rico's electric system and to inform strategic resource planning decisions. The first Resource Adequacy Study covered Fiscal Year 2023 (July 2022 – June 2023). The study is available on the PREB's website, under docket No. NEPR-MI-2022-0002.

The Resource Adequacy Study quantifies the risk that an electrical system is unable to serve the system load because of deficient generation capacity. In the past, resource adequacy analyses focused primarily on having sufficient generation capacity to meet peak load times. However, support has grown for rigorous probability-based analyses that consider every hour of the simulated time horizon due to the growth of intermittent sources, such as renewable sources; changing electrical load profiles due to behind-the-meter generation growth; or shifting peak hour demand.

The Resource Adequacy Study for FY2023 (issued in August of 2022) showed that while the industry target Loss of Load Expectation (LOLE) is 0.1 days per year, in Puerto Rico the expectation of a load shed event is 8.81 days of the year. This represents 80 times as many load-shed events as can be experienced in the mainland US. However, it is important to note that during recent years Puerto Rico has operated with an amount of available capacity operating with at least one baseload generator out-of-service for a prolonged period. With one baseload generator out-of-service the LOLE was 28.08 (or approximately 280 times the typical North American planning standard). For Puerto Rico to meet a LOLE target of 0.10 days per year it was determined that a perfect capacity of 675 MW was required. "Perfect Capacity" refers to the generation capacity that is always available, 100% of the time, for each hour of the year.

Given that no generation technology can operate as a perfect generator, the actual amount of capacity required for the system to meet 0.10 days/year would be somewhat higher than the 675 MW. The size of the new generating resource would also vary by generator technology type. For example, a larger capacity of solar photovoltaic (PV) paired to energy storage would need to be added for the system to meet a 0.10 days/year LOLE target than capacity from combustion turbines, reciprocating engines, standalone energy storage (storage that can charge from the grid, regardless of the generation source), or other similar technologies, since solar PV can only generate electricity during the daytime. Modifications to existing generators that improve reliability would also help to improve overall system resource adequacy.It is important to note Puerto Rico's generation adequacy worsened significanly after Hurricane Fiona in October 2022 and efforts were undertaken subsequently to introduce emergency generation to Puerto Rico and improve the critical generation supply situation.

Challenges to Resource Adequacy

With respect to generation, Puerto Rico is exposed to higher risks of capacity shortfall than many other places due to:

- Planned Maintenance Length: Puerto Rico has an aging fleet of unreliable power plants that often require lengthy maintenance outages to continue operation.

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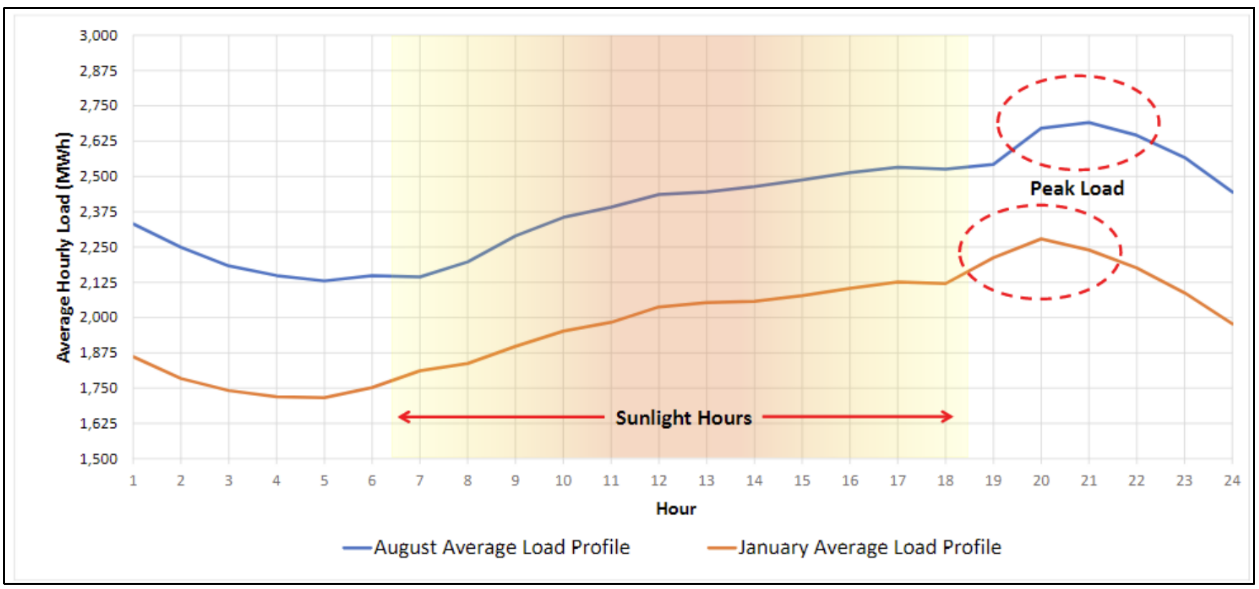
- Forced Outage Rates: Since many generators of the fleet have not been properly maintained, they are often derated and experience very high forced outage rates.
- Portfolio of Large Generators with Low Redundancy: Since the generation portfolio is dominated by large generators, outages to a large single unit increase the risk of generation shortfalls.
- Islanded System: As an island, Puerto Rico cannot import electricity from neighboring utilities when needed.

Puerto Rico Electrical Load and Reserves Margin

The electrical demand, also referred to as the load, is an important element in resource adequacy evaluations specifically because system generators must be able to meet the electrical demand for every hour. The following figure illustrates this variance by presenting the hourly load profile, averaged over each day, for August 2022 and January 2023 (the highest and lowest load months, respectively). As can be observed in the figure, load steadily rises throughout the day, peaking in the evening. From a resource adequacy perspective, the hourly load profile is important because it identifies when generation is needed most. The fact that the load profile peaks in the evening also highlights a challenge that many other utilities with large amounts of solar generation are currently facing: stand-alone solar power plants are unable to contribute generation to help meet the evening peak since the sun would have already set. Solar power resources must be paired with energy storage in order to contribute generation during the evening peak. The size and duration of the storage systems are important considerations in determining if solar resources will contribute to resource adequacy at peak.

Figure 5.1 – Forecasted FY2023 Electrical Load Profile – Hourly Averages



Given the high outage rates and derates of the existing power plants in Puerto Rico, a simple comparison of the Reserves Margin in Puerto Rico to the Reserves Margin values in other similar locations masks the significant challenges Puerto Rico faces daily concerning generation resource adequacy, as shown in the figure below. It is correct that there is a substantial amount of generation installed in Puerto Rico; however, the majority of that generation is unreliable and too frequently incapable of operating when electricity is needed.

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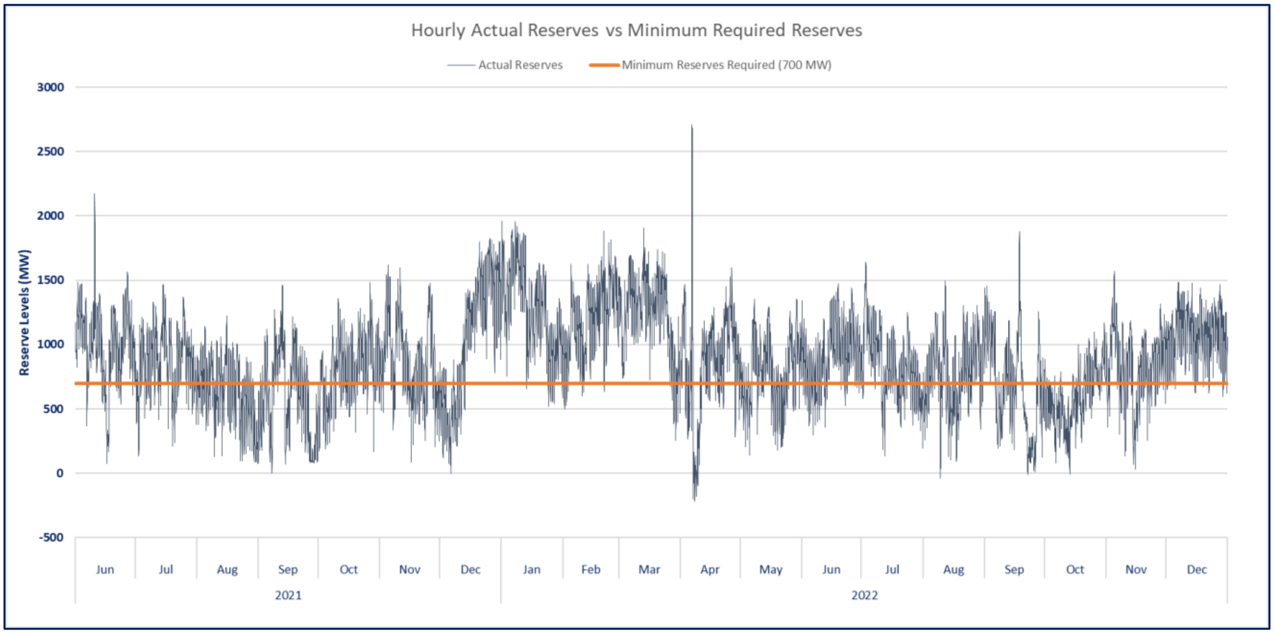
Figure 5.2 – Hourly Actual Reserves versus Minimum Required Reserves



6.0 Compliance with System Operation Principles

6.1 LUMA Compliance with System Operation Principles

On February 21, 2021, LUMA submitted System Operation Principles to the Puerto Rico Energy Bureau (the Energy Bureau) per the Transmission and Distribution System Operation and Maintenance Agreement (T&D OMA). On May 19, 2021, LUMA submitted to the Energy Bureau a revised version of the System Operation Principles (SOP). The Energy Bureau approved the SOP by Resolution and Order of May 31, 2021 in Case No. NEPR-MI-2021-001. Pursuant to the Energy Bureau's Resolution and Order of May 31, 2021, LUMA submitted to the Energy Bureau, on December 23, 2021, final versions of twenty-nine (29) SOP procedures necessary for the operation of the system.The SOP describes how the Bulk Power System (BPS) will be operated. This section will outline how LUMA has complied with the SOP during the first year and a half of operations, and the progress made.

At the time of LUMA's commencement on June 1, 2021, there were no existing procedures at PREPA's Energy Control Center for operators to use in the operation of the BPS. This was a significant deficiency that needed to be addressed immediately. Therefore, before commencement, LUMA worked closely with PREPA management and operators to assess the "as-is" processes and document how the grid was being managed. This exercise provided LUMA with identification and documentation of all major processes, identification of existing gaps that would enable LUMA to prepare to address situations such as emergency response or black start, and helped in prioritizing opportunities for improving processes.

The following sections describe LUMA's role in bridging the gaps between the "as-is" condition of the processes and what was necessary to operate the BPS as described in the SOP. The sections are written in parallel order to how they appear in the SOP for easy tracking of compliance with SOP commitments.

6.1.1 System and Resource Planning

Some of the System and Resource Planning components include load forecasting, resource adequacy studies, integrated resource plan, and various requirements for interconnected generation resources for which LUMA is responsible for the coordination across these areas.

Load Forecasting

In terms of load forecasting, LUMA created a single load forecast, which will be updated on an annual basis. In the fall of 2021, LUMA engaged an external consultant to support the development and improvement of its long-term load forecasting process. The Annual Load Forecast is the long-term (20+ years) forecast used for projecting revenues, setting rates and rate-riders and is a key input to its Integrated Resource Plan, among other things.

LUMA has commenced an improvement process to its load forecasting procedures to deliver a more accurate and useful forecast of monthly class-level consumption, and annual system peak demand. This improvement process will also allow it to provide a Long-Term Load Forecasting Procedure to support the SOP as specified in the Energy Bureau's Resolutions and Orders of May 31, 2021 and August 25, 2021 in Case No. NEPR-MI-2021-0001.

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LUMA has identified to the Energy Bureau within LUMA's filing on September 13, 2021, and during the Technical Conference on September 17, 2021, that there are five phases of this work. The descriptions below are based on the phase details in the submission of September 13, 2021.

- Phase 1 – Internal Governance and Organizational Design
- Phase 2 – Review Current and Future Methodologies
- Phase 3 – Establish Data Needs
- Phase 4 – Process Design
- Phase 5 – Build Capabilities

Along with the long-term forecast, LUMA has developed and implemented SOP Procedure 1 "Short Term Load Forecasting" which includes the process for generating daily, weekly and monthly load forecasts. To provide the public with more information on the operation of the system, LUMA is publishing on its website[8] a daily 24-hour forecast and the previous 12-hour demand graph.

Integrated Resource Plan

Under the T&D OMA, LUMA is responsible for undertaking the development of a new Integrated Resource Plan (IRP) for Puerto Rico that must be filed on March 2024. The IRP considers all available and future resources to meet annual energy demand and supply during a 20-year period. The last IRP, filed by PREPA in 2018, was approved by the Energy Bureau in 2020, in docket CEPR-AP-2018-0001. Until July 12, 2023, docket NEPR-MI-2020-0012, *In Re: Implementation of the Puerto Rico Electric Power Authority Integrated Resource Plan and Modified Action Plan*, was used for IRP pre-filings and ongoing initiatives of the previous 2018 PREPA IRP. On June 12, 2023, the Energy Bureau opened docket NEPR-AP-2023-0004, *In Re: Review of the Puerto Rico Electric Poewr Authority Integrated Resource Plan*, to initiate the administrative proceeding for the review of the proposed IRP to be filed by LUMA as PREPA's agent. To complete the IRP, LUMA is subcontracting a qualified IRP technical consultant, and a stakeholder coordinator to assist with all stakeholder engagements. IRP-related studies and analyses currently ongoing include the Distributed Energy Resources, Incremental Hosting Capacity Study, a Transmission study, and updated peak load and energy forecast. LUMA and DOE are collaborating and sharing data study results for the benefit of DOE's PR-100 and the IRP.

Resource Adequacy Studies

LUMA coordinates a Resource Adequacy assessment to be completed annually. The first Resource Adequacy Study has been completed and filed to the Energy Bureau in docket NEPR-MI-2022-0002, In Re: LUMA Resource Adequacy Study, which outlined the significant generation challenges Puerto Rico faces due to the years and decades of neglect the system has suffered. This study assesses the sufficiency of electricity generation owned and operated by the Puerto Rico Electric Power Authority (PREPA) and other generators to meet existing electric customer load requirements in Puerto Rico by evaluating the risk of loss load during the 12-months, beginning on July 1, 2022, or Fiscal Year (FY) 2023. LUMA, which does not generate electricity, carried out this analysis in compliance with its responsibilities

[8] System Overview - LUMA. https://lumapr.com/system-overview/?lang=en

under the T&D OMA to inform the Energy Bureau, policymakers and stakeholders about the adequacy and inadequacy of generation resources in the Puerto Rico electric system and to inform strategic resource planning decisions. A summary of the Resource Adequacy Study is found in Section 5.0 of this report.

System Operations Report

Interconnected Generation Requirements

Any new generator must submit a request to LUMA to connect a new generation unit to the system. To ensure safe and reliable operations and to standardize the rules by which interconnected facilities interact with the grid, LUMA has developed SOP Procedure 2 “New Facility Interconnection” which defines the interactions between Transmission Operations with LUMA stakeholders and the new facilities during the projects’ lifecycle. As an example, for the Tranche 1 Request for Proposals (RFP) and Tranche 2 RFP, the procedure for requiring interconnected studies was imbedded into the RFP process, an interconnection queue for non-RFP projects has been developed and will be implemented during FY 2023, and a Large Generator Interconnection Agreement (LGIA) was developed in advance of the closure of Tranche 1 and the same was included among the documents published in connection to the Tranche 2 RFP.

The objectives of an LGIA are to:

1. Provide a transparent and efficient means to interconnect generation resources to the electric power system
2. Maintain the safety, reliability, and power quality of the electric power system

The execution of the LGIA is a requirement for all new RFP projects, and discussions are ongoing with the new generators to adopt the LGIA. The LGIA refers to compliance with the SOP and its related procedures.

In the case of existing legacy PREPA plants, LUMA has developed the Agreed Operating Procedures (AOP) as a set of procedures to assist the legacy generation plants and System Operations in the day-to-day management of the facilities, under the T&D OMA. This document was created per applicable laws and regulations, the SOP, and Prudent Utility Practice. Throughout the year, LUMA personnel held multiple meetings with PREPA’s Generation Director, Generation System Operations Director, and Plant Managers to discuss the development and implementation of the AOP. The AOP addresses topics such as the declaration of capabilities, dispatch of dependable capacity, the scheduling of PREPA and other generator units’ generation, the scheduling of generation-related outages, among others. In addition, a Legacy Generation Asset Interconnection Agreement was developed for execution with the private operator of the Legacy Generation Assets that is contemplated per the terms of the PREPA-GenCo-HydroCo Operating Agreement (PGHOA). This is an important step to ensure SOP compliance with all generators.

Additionally, existing Independent Power Producers (IPPs) operate following a Power Purchase Operating Agreement (PPOA) signed by the IPP and PREPA (now managed by LUMA as an agent of PREPA), which has the purpose of providing a set of rules and procedures on how the generators will interact with the grid and with System Operations, in compliance with the SOP and T&D OMA.

Per the IRP, several generation unit retirements will take place in future years. All generation retirements must be completed following Prudent Utility Practice and the IRP, approved by the Energy Bureau. These changes must be informed to the System Operator. To ensure a uniform process upon unit retirements, SOP Procedure 4 “Interconnected Facility Retirements” was created. This procedure defines the steps to follow when retiring an existing interconnected facility, including scheduling and proper notifications.

6.1.2 Data Management

Data management and data security are critical to making informed decisions, and they are vital components of stable and efficient operations. For a System Operator, it is important to have defined processes to maintain the accuracy of data, as well as strict data security protocols in place to protect all critical data used in the operation of the BPS.

Data Management Mechanisms

Two procedures were developed to address data management: SOP Procedure 8 “Telemetry,” which outlines the steps to be followed for requesting, approving, and securely interfacing additional telemetry points for the Supervisory Control and Data Acquisition (SCADA) system, and SOP Procedure 9 “Cybersecurity,” which addresses cybersecurity matters related to the installation of new or the addition of Remote Terminal Units that communicate to System Operations via an electronic interface. LUMA provides extensive training to personnel on data management protocols, including initial training (which includes data management) that is provided during the hiring process by the Human Resources Department, under the Code of Conduct and the Cybersecurity Department's training strategies. To enhance data security and management, a firewall upgrade and segmentation of the existing SCADA system was completed, older non-supported hardware was replaced to facilitate defense-in-depth and have redundancy onsite and offsite, and user role-based access controls were implemented. Finally, LUMA continually performs cybersecurity awareness campaigns with all employees to build cyber awareness and identify risks.

Cybersecurity

In response to the immediate and growing threat of cyberterrorism, the System Operator developed a cybersecurity strategy to outline how it would increase data security. The strategy is composed of four main areas of focus:

1. Build a Culture of Security
2. Project Support and Security Governance,
3. Improved Monitoring
4. Incident Response

Among the completed Cybersecurity Strategy actions include the following:

- Established a mandatory security training as part of employee onboarding, approved and implemented an Acceptable Use Policy for all LUMA technology users;
- Established and created a Security Assurance Plan for project security governance;
- Supported security architecture and awareness of security controls to pre-commencement projects;
- Increased the scenarios and log sources monitored in the Security Information and Event Management (SIEM);
- Completed and remediated penetration tests on external systems;

- Added administrative accounts to the Privileged Access Manager to ensure all external communications with the SCADA system are reviewed by the Cybersecurity team before being approved by the Telecoms Engineering team, and data encryption is required for any external communications.

As a result of these efforts, the cybersecurity team has been able to respond to several methods of Distributed Denial-of-Service (DDoS) attacks on LUMA's public-facing systems.

6.1.3 Energy Dispatch

Energy Dispatch is the process of balancing and allocating system resources based on customer load, economic operation, system reliability, stability and safety.

Allocation and Dispatch of System Resources

The System Operator depends on the collection of secure, accurate, and timely data to be able to allocate resources more efficiently and effectively. As part of the process to collect reliable data, the System Operator defined various communications protocols to address different situational needs. SOP Procedure 21 "Plant Level Communications" was developed to ensure proper communications are established and maintained. Additionally, each Independent Power Producer (IPP) is bound by a Power Purchase Operating Agreement (PPOA), which guides each party on the correct communications between the generators and the System Operator. For legacy generation plants (PREPA), an Agreed Operating Procedure (AOP) was developed and is awaiting PREPA signature. The AOP also delineates how data and communications will be carried out by the parties. Additionally, SOP Procedure 6 "Interconnected Facilities Capabilities" requires interconnected facilities to communicate their specific performance and capabilities regularly to the System Operator.

To increase each plant's reliability and resilience, as well as the overall Transmission System, different control and automation procedures have been established. For example, SOP Procedure 25 "Scheduling Planned Transmission and Generation Outages" outlines how to manage outages with proper scheduling and prioritization. SOP Procedure 27 "Outage Execution and Closeout" details the phases for scheduled planned outages from the planning phase, to the execution, to the close-out of the outage.

In terms of improving automation procedures for the Automatic Generation Control (AGC) to manage generation and availability, PREPA and LUMA have met to develop the process of regulating frequency through the AGC. Communications tests with two of the San Juan units were performed to confirm commands sent by the Transmission Operations Center (TOC) were received properly. Additional regulating tests will be coordinated in the future. Currently, LUMA is awaiting PREPA's response on the technical parameters of the baseload units to update the AGC database.

As previously established, the System Operator must have accurate and timely data to be able to operate the Transmission System efficiently and effectively. For this reason, SOP Procedure 19 "Energy Dispatch, Scheduling & Merit Order" outlines the steps defined considering check-points related to data gathering, dispatch plan for each shift, validation of current load forecast, generation capacity and available capacity, verifying transmission status, constructing the dispatch schedule, communicating the dispatch schedule, executing the shift plan, among others. This procedure aids in creating different dispatch scenarios, prioritizing generation dispatch in a sequence that considers both economics and reliability, and defines the criteria to guide how dispatch is sequenced.

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Non-Discriminatory System Operation

The System Operator treats all system resources in a non-discriminatory manner, per public policy. Non-discriminatory dispatch means that the System Operator does not consider asset ownership in the decision-making process, and the option that is least costly to consumers is selected when possible, considering reliability and system security.

The System Operator dispatches all plants following System Operation Principles, Prudent Utility Practice, among other operating agreements, all production data is recorded in SCADA to minimize monthly costs invoiced by the generator, as well as for LUMA personnel to validate the invoice and payment requirements under the commercial terms of the PPOA. LUMA has developed internal procedures to document how the data is collected and validated against the generator's invoice.

As a part of LUMA's efforts to increase involvement with generators and other stakeholders, LUMA is providing and publishing more information to the public related to the progress on the system transformation (such as this report and the Resource Adequacy Study), and a public site to show the daily system supply and demand on LUMA's website[9]. Another important step toward increasing involvement with the generators is the formation of the Generation Stakeholder Committee. This Committee is composed of representatives from LUMA and each of the interconnected facilities, and it intends to address matters such as planning, operations, and system improvements on the BPS. SOP Procedure 13 "Stakeholder Management" was developed to aid in the management of such Committees and others that may be formed in the future.

Future developers are important stakeholders to LUMA, therefore during the period of Tranche 2, LUMA participated in the Energy Bureau and ACCION Group Technical Stakeholder Meetings and responded to questions from developers submitted through the PREB-IC website[10].

Addressing Insufficient Generation and Transmission Resources

As the System Operator, LUMA is responsible for analyzing and evaluating the overall resource inventory of the system. To this end, LUMA has filed with the Energy Bureau the Resource Adequacy Study for FY 2023 (refer to Section 7.0). The System Operator is also responsible for implementing a defined response plan for any area impacted by insufficient generation and/or transmission resources. Currently, LUMA is issuing load shed warnings through official communications and social media announcements with information in individual events available via a publicly available load shed map[11]. These types of warnings are issued to all customers via news outlets and social media in advance of anticipated generation shortfall events from PREPA and other generators. Additionally, a Demand Response program was developed, including Emergency Demand Response Program, which was filed with the Energy Bureau as part of LUMA's Energy Efficiency Demand Response Transition Period Plan ("TPP") on June 21, 2022 in docket NEPR-MI-2021-0006, *In Re: Demand Response Plan Review, Implementation and Monitoring* (its implementation being followed now under docket NEPR-MI-2022-001, *In Re: Energy Efficiency and Demand Response Transition Period Plan*), which TPP was considered, amended and

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[9] System Overview - LUMA. https://lumapr.com/system-overview/?lang=en

[10] *PREB-IC RFP*. (n.d.). https://prebrfp.accionpower.com/_preb_2101/logged_on_home.asp

[11] *ArcGIS Dashboards*. (n.d.). https://aeepr.maps.arcgis.com/apps/dashboards/1995c773fceb468db8b7f7d34899df94

approved by the Energy Bureau. LUMA has also communicated directly with large industrial customers to request load reductions on numerous occasions in preparation for a generation shortfall event.

Load shed events can occur for multiple reasons. The most common categories are: automatic load shed events, which may occur when there is a loss of a generation unit or a sudden load reduction that doesn't allow the system frequency to be maintained in target levels; manual load shed events, which are typically planned events that occur when there is a generation deficiency in the system; and contingent load shed events, which take place during emergency events, under which the System Operator will also follow SOP Procedure 28 "Emergency Response Execution." Load shed events follow a defined set of rules to minimize the impact on employee and public safety, equipment damage and customers. These rules are outlined under SOP Procedure 17 "Load Shedding". This procedure addresses the steps to follow after automatic, manual, or contingent load shed events.

It's important during a load shed event to identify which critical infrastructure and facilities should remain online, when possible. Such critical infrastructure and facilities may be composed of hospitals, telecom facilities, wastewater treatment facilities, emergency response facilities and others. These critical infrastructure and facilities, or specific customers, have been identified and are listed in LUMA's Emergency Response Plan (ERP). To further improve the identification of critical infrastructure and facilities and how they are handled during an outage or a load shed event, information is being collected on these customers to integrate them into the GIS system and LUMA's customer information system. Finally, the Puerto Rico Department of Economic Development and Commerce is in the progress of assessing the inventory of critical customers on the island, and LUMA is in the process of acquiring a copy to integrate with the different systems and the ERP. Once complete, the inventory information will be updated in LUMA's customer information system and integrated with company systems for outage or load shed management.

6.1.4 Operating Parameters

LUMA, as System Operator, has established policies and procedures related to the operation of the system. The objective of these policies is to ensure stable, safe operations and actions to be taken including defining resources to be used when operations fall outside of these ranges.

Reserves and Line Loading

SOP Procedure 14 "Policy on Reserves" was developed to establish the reserves requirements to address load and generation imbalances, as well as the timeliness of receiving reserves. These policies include specifications that apply to existing generators, storage, and other non-wire alternatives. The procedure describes the difference between Operating Reserves and Contingent Reserves. It also describes the appropriate reserve requirements to restore the spinning reserves after a disturbance, once the system has been restored to pre-contingency levels.

System Risk Management

Based on the understanding of the factors that could threaten or disrupt service, System Operator has defined procedures for controlling and preserving steady-state power system stability. The 29 SOP procedures contribute to this objective, however the SOP procedures that have direct impact include procedures that: describe how to perform a short-term load forecast and the importance to the management of the Transmission and Distribution system (SOP Procedure 1 "Short-Term Load Forecasting"); consider the necessary quality checks, identification of recurring resource adequacy issues, and development of near-term resource analysis (SOP Procedure 3 "Resource Adequacy

System Operations Report

Planning"); ensure a proper system monitoring (SOP Procedure 19 "Energy Dispatch Scheduling and Merit Order"); describe the role of the Transmission Operations Center (TOC), receiving, processing, scheduling, and executing clearance order requests from transmission, substation, generating stations, and generating units (SOP Procedure 20 "Transmission Operations"); describe how a System Operator meets and passes assessments and testing to become an independent system operator on the BPS (SOP Procedure 24 "System Operator Training"); and provide direction to the TOC on how to manage the BPS frequency and voltage in a continuous manner (SOP Procedure 22 "Balancing Frequency and Voltage").

To minimize disruptions to the system caused by contingencies, the System Operator has established a procedure to provide a baseline on consistent service and guidance when generating units have deviated from those instructions. SOP Procedure 21 "Plant Level Communications" defines the steps to develop clear methods of communication, protocols, facility scheduling, energy dispatching, capability dispatching, transfer of data, and management of emergency activities. To this end, the AOP were developed as an agreement between the Legacy Generation Facility Operator and the System Operator, and each IPP is bound by a PPOA which outlines the parameters the plants are required to follow.

Additionally, to minimize the impact of load shed events and establish a requirement for contingency planning SOP Procedure 15 "Reducing Risk Exposure to Contingencies" establishes the requirements to maintain situational awareness using telemetry data and field observations to assess and react optimally to avert contingencies from occurring. This approach is necessary to maintain the system's safety and operation, and act by following other procedures as circumstances dictate. SOP Procedure 16 "Critical Loads" contributes by establishing tasks for transmission and communication with distribution to ensure that critical loads are maintained and configured safely. In the event of a service interruption to a critical load, all efforts will be made to restore those loads as expediently as possible. Finally, SOP Procedure 17 "Load Shedding" established the steps to follow to allow load-relief and minimize the impact of a load shed event. Aside from the SOP Procedures, the System Operator needs to maintain continuous communication with the generation plants in the case of preparation and execution of load and the steps to follow after a load shed event.

Transmission Operating Limits

To keep the power system operating within safe, stable, and reliable levels of energy flow, the System Operator will follow SOP Procedure 18 "Contingency and System Operating Limits Response" which provides a systematic approach for maintaining transmission system continuity of service by quickly and effectively responding to adverse events. The System Operator will also follow SOP Procedure 20 "Transmission Operations" which addresses the conduct of routine and emergency transmission clearance order requests and subsequent switching operations.

Additionally, to define transmission operating limits that reflect the appropriate facility rating, voltage stability, and transient stability a two-part model is being developed. The first part is the Steady State, this phase considers a security analysis required to obtain an N-1, N-1-1 security level, for which the functional specifications have been determined. The next steps in this phase are to complete the engineering design and create a project plan to implement it. The second part under development is the Dynamic State, which affects voltage stability and transient stability. The existing dynamic state model is being used as a baseline; however, it will be modified for increased accuracy. Collaboration from PREPA is needed to successfully finish the model improvement. This model will aid in the evaluation and prioritization of multiple contingencies and prioritize the order in which to address them.

6.1.5 Energy Management System

One of the fundamental elements of Prudent Utility Practice is a fully functioning energy management system (EMS). Upon LUMA's commencement, the existing EMS was no longer supported by the vendor and did not have the functionality to adequately manage and control a modern grid with a large portion of renewable resources. To implement a new EMS, LUMA has created a project, which forms part of the System Remediation Plan (SRP), to bring the system to a remediated state. In FY 2022, LUMA established business and technical requirements with which the EMS should be compliant. Currently, the project is in the process of evaluating and selecting a vendor, as well as completing the requirements for the federal procurement process for FEMA-compliant engineering services.

6.1.6 Outage Scheduling and Reporting

System outages occur for a variety of reasons. Whether planned or unplanned, the System Operator must coordinate and approve all generation and transmission outages. SOP Procedure 25 "Scheduling Planned Transmission and Generation Outages" provides direction regarding the required steps for outage requests, length of outages and return to service. It also addresses the safe, timely and efficient analysis, approval, scheduling, documenting and communications of BPS planned outages before the actual execution of the outage. Furthermore, SOP Procedure 27 "Outage Execution and Closeout" details the phases for scheduled planned outages from the planning phase, to the execution, to the close-out of the outage.

In addition to coordinating and scheduling outages, the TOC is required to respond, manage, and restore the electrical system following a forced outage. SOP Procedure 26 "Forced Outages" and SOP Procedure 27 "Outage Execution" guide the interconnected facilities and the System Operator in responding to outage events.

Learning From System Events

LUMA has developed a process to investigate and analyze system events in generation and transmission and, subsequently, to perform a root-cause analysis of significant system events as required by the SOP. SOP Procedure 10 "Root Cause Analysis and Corrective Actions" details the initial response to an adverse event, data and materials collection, and formation of the Root Cause Analysis (RCA) team, among others. As part of the RCA process, lessons learned are shared across pertinent teams, such as the transmission and distribution teams, and corrective actions are implemented in a timely fashion to improve the overall reliability of the system.

6.1.7 Emergency Response

Emergency Events

LUMA has created an Emergency Response Plan (ERP) which was originally filed with the Energy Bureau in May 2021 in case NEPR-MI-2019-0006, *In Re: Puerto Rico Electric Power Authority's Emergency Response* Plan, and updated in filings on May 2022 and May 2023. The ERP addresses electric utility emergency response to any disaster and addresses customer outages due to natural causes (e.g., thunderstorms, hurricanes, tornadoes, storm surges, earthquakes, tsunamis, etc.), human causes (e.g., major equipment failure, civil unrest, terrorism, wildfire, etc.), and technological causes (e.g., dam failures, transportation accidents, etc.), resulting in significant customer interruptions. The ERP is predicated on knowing and understanding the magnitude of the event. The Major Outage Restoration

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Annex included in the plan operationalizes the sequence of energy restoration revolving around key infrastructure that supports the protection of life and property.

Following the process established in the ERP and the SOP Procedures for emergency response, LUMA has developed SOP Procedure 29 “Emergency Response Drills”. This procedure requires the System Operator to participate in Emergency Drills and to know and understand their emergency roles, procedures and actions to effectively respond to, manage, and restore the electrical system. LUMA also participates in coordination meetings with the Puerto Rico Emergency Management Bureau (PREMB), Federal Emergency Management Agency (FEMA), and other government agencies as necessary.

As part of the emergency preparedness effort, the System Operator has prepared a list of actions to be followed during significant system events and disturbances to the electric system, such as is the case with hurricanes, storms, equipment malfunctions and operating errors. The System Operator will follow SOP Procedure 28 “Emergency Response Execution” and the ERP during emergency events.

Following industry best practices, LUMA, in collaboration with the Department of Energy (DOE) and the Pacific Northwest National Laboratory (PNNL), developed a preliminary damage prediction model to more easily identify the expected damages from a hurricane and to support restoration activities once damage assessment of the event is completed. The model will consider the hurricane category to obtain more accurate predictions. Data from Hurricane Maria and Irma was used to develop the model. The accuracy of the model will improve as more storm data becomes available.

From the System Operator side, a procedure was created to address the restoration plan for the BPS following a major or total blackout. SOP Procedure 7 “Black Start” was filed with the Energy Bureau on December 2021 and is part of the 29 procedures created to operate the system following Prudent Utility Practice. As part of the Black Start procedure and SOP Procedure 16 “Critical Loads,” the System Operator has developed a process for on-shift operators, which outlines the primary steps to restore the system securely. Additionally, SOP Procedure 29 “Emergency Response Drill” requires the System Operator to participate in emergency drills and know and understand their emergency roles, procedures, and actions to effectively respond to, manage, and restore the electrical system. System restoration is required to be drilled annually to aid in the execution during a real event.

Resource Adequacy

For the System Operator to address any shortfall in resource adequacy, LUMA has proposed a plan for alternatives to serve as a near-term bridge (less than three years) to achieve resource adequacy. This plan includes: Tranche process, emergency installation of temporary units, a demand response program, increased consumer outreach related to energy efficiency and voluntary conservation efforts. Working toward this goal, LUMA has written the Resource Adequacy Study (further discussed in Section 7.0 of this report), filed with the Energy Bureau on August 2022, in docket NEPR-MI-2022-0002, to inform the public and all parties involved of the potential impact to the Puerto Rico electric system if the identified issues are not resolved. The information contained in this report has been discussed in various technical conferences with the Energy Bureau and has helped in highlighting the importance of addressing the existing gaps in resource adequacy.

Critical Loads

During emergencies, critical infrastructure and facilities are prioritized for restoration of service to sustain essential services and maintain community functionality. LUMA has developed SOP Procedure 16 “Critical Loads” to identify, maintain and update the list of critical infrastructure and facilities, respond to a trigger event, and identify emergency self-generation customers listed as critical. The procedure emphasizes the importance of prioritizing the collection of loads or customers to avoid load shed and prioritize restoration. These customers may include hospitals, telecom facilities, wastewater treatment facilities, emergency response facilities and other critical infrastructure. All the emergencies are handled following SOP Procedure 28 "Emergency Response Execution," SOP Procedure 29 "Emergency Response Drills," and LUMA's Emergency Response Plan (ERP).

6.1.8 Balancing Frequency and System Impacts

To maintain a balanced system and minimize impacts wherever possible, the System Operator has created SOP Procedure 22 "Balancing Frequency and Voltage," which provides direction to the TOC personnel to utilize generation and transmission elements to control the BPS's frequency and voltage. The procedure provides the steps necessary to anticipate and mitigate system imbalances as well as respond to real-time imbalances related to frequency and voltage. Additionally, the operators in the TOC use the SCADA system to monitor the real-time performance of each generation unit, necessary for the balancing of frequency and voltage in the system.

6.2 Generators' Compliance with System Operation Principles

6.2.1 Managing Systems Operations Issues and SOP Violations

LUMA regards the System Operations Principles (SOP) as the basic ground rules between Generators and the System Operator for operating the Bulk Power System (BPS) safely and reliably. Regular communication occurs multiple times a day between LUMA's System Operations personnel, PREPA generation plants' personnel and other generation plants' personnel to coordinate system operations and for issuing resolutions, per the SOP.

When a violation of the SOP occurs, LUMA prefers to resolve it by addressing it directly with the plant and/or generation operations personnel involved using established communication channels for working together. Transmittal # LUMA-PREP-T-00219 (item #4.3 in Appendix C.) for example, describes a series of emails and phone calls between LUMA and PREPA personnel and executives to obtain data from PREPA to enable LUMA to fulfill its obligations as System Operator under T&D OMA and in accordance with the SOP.

In some exceptional instances, specific SOP violations are escalated by letter to the appropriate PREPA executives, such as the Executive Director, the Deputy Executive Director, the Chief Financial Officer, the Generation Director and/or the Generation Director of Operations. These letters generally explain the situation and request information and/or remediation from PREPA's executives. SOP violations are escalated when acts or events ignore Prudent Utility Practice, cause a significant destabilization risk to the BPS, deliberately undermine the agreed upon SOP, risk critical power losses for the Puerto Rican consumer, or ignore repeated requests for information or cooperation through the normal channels mentioned previously.

6.2.2 Issue Escalation

Between June 1, 2021 (LUMA's commencement) and December 31, 2022, LUMA and PREPA exchanged 29 letters about the SOP. Approximately one-half (1/2) of these letters were information exchanges between LUMA and PREPA; the other one-half (1/2) described PREPA's non-compliance with its obligations under the SOP and the T&D OMA.

Additionally, LUMA and AES exchanged 2 letters related to SOP. Both of these letters were information exchanges, and there were no non-compliance letters required to be sent to AES. No other letters regarding SOP were sent to the other interconnected generators.

A summary of the SOP issues escalated by letter is shown in Appendix C.

Appendix A: Generation Performance Report
June 1, 2021 – December 31, 2022

Appendix B: System Operator Major Changes Since June 1, 2021

Table B.1 – System Operator Major Changes Since June 1, 2021

Inherited Conditions	System Improvements
1. Improvement: Developed agreements between PREPA and LUMA to separate generation assets from T&D assets including PREPA-GenCo-HydroCo Operating Agreement, Agreed Operating Procedures, and detailed Demarcation Plan	
• No organized, defined PREPA Generation Company (GenCo) was in existence on the first day of LUMA operation despite this being an explicit expectation defined in the T&D OMA and required by Puerto Rico law • No agreed, written plan to demarcate and separate Generation from Transmission and Distribution (T&D) assets on day one of LUMA's operations as required by the T&D OMA • No written documents of any kind describing how PREPA and LUMA should coordinate communications and exchange of operational data • No clear path was defined for how necessary documents were to be developed given that PREPA personnel had not been told anything about the new structure or documents and the continued uncertainty about the start date for the new generation operator	• AOPs and Demarcation Plan negotiated between LUMA and PREPA working groups; still awaiting final signatory approval from PREPA • Written Demarcation Plan identifying specific assets in the generation control room and switchyards that are to be under the responsibility of PREPA or LUMA personnel, as well as operational procedures defining how this work will be done

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Inherited Conditions	System Improvements
2. Improvement: Creation of Thermal and Renewable Stakeholder Committees to provide IPPs a forum to discuss issues and improvements with LUMA as the System Operator	
• Informal, undocumented one-on-one dispute resolution process and decision-making with poor documentation that left a perception of arbitrary favoritism • No ability for generator IPPs to communicate a coordinated message to the Energy Bureau or the electric customers of PREPA about generator capacity and energy deficiencies • No structured, objective way for common issues to be constructively discussed that might affect all generators (e.g., synchronization, system protection, communications and dispute resolution) • Completely inadequate structural and process-related mechanism to administer an IPP sector that is expected to grow from 12 generators today to over 150 generators under the currently expected 6-Tranche program • No comprehensive emergency response plan that engaged and coordinated all generators as equals	• Early steps completed to build the foundation for a successfully unbundled BPS inside Puerto Rico in 3-5 years that mirrors how every generator in the mainland U.S. operates • A structured process to identify and implement changes that benefit the entire BPS by working cooperatively together through Stakeholder Committee working groups or speaking in one voice to communicate to Regulators or Stakeholders about future industry issues • A structure that is capable of scaling up to manage and administer over 150 or more PPOAs in a consistent, non-discriminatory manner • A process to solicit and learn from generators what could be done better following major storms
3. Improvement: Implemented processes and procedures to treat all generators equally in a non-discriminatory manner	
• No written rules or procedures describing how Power Purchase Operating Agreements (PPOAs) should be constructed or administered • Treatment of generators under PREPA was poorly documented and could be perceived as arbitrary and reflected in ad-hoc and inconsistent decision-making and informal agreements • Poorly worded PPOA terms and conditions with excessive giveaways to generators (e.g., agreement that if another PPOA were ever signed for a higher price, PREPA would match that higher price by increasing an existing PPOA price) • Inconsistent level of documentation, terms and conditions, and requirements among PPOAs • Several ongoing unresolved billing disputes dating back 5-8 years	• Completion of the first-ever SOPdocument, conditionally approved by the Energy Bureau and describing for the first time, how the BPS is supposed to operate • Over 500 pages of explicit, written procedures describing policy requirements, roles and responsibilities, criteria for key decisions between Generator IPPs and System Operations • Consistent non-discriminatory treatment of all generators on an equal basis • Creation of a single Large Generator Interconnection Agreement (LGIA) to be used consistently for all generators • Re-written AOPs to further define terms of PPOA obligation and procedures to minimize what could be seen as arbitrary decisions • Resolution of all outstanding past billing disputes between IPP Generators

Inherited Conditions	System Improvements
4. Improvement: Introduced tools for better security-constrained economic dispatch, including programs for installation of a new Energy Management System to allow better visibility of the system and direct control, Automatic Generation Control so the generation units can make quick adjustments to output to maintain system operating parameters without affecting customers, and non-discriminatory decision processes for system operations	
• Reliance on broadly estimated assumptions with infrequent validation checks (e.g., heat rates had not been validated in ten years), multiple sources of related performance data used for different applications with inadequate coordination and quality control • Incomplete application of technology and tools such as metered measurements of power plant output, failure to utilize installed Automatic Generation Control (AGC) systems at several plants • Obsolete hardware and software such as Energy Management System (EMS) and control room equipment dating from the 1990s that is no longer supported by Original Equipment Manufacturer (OEM) and cannot adequately support several utility functions such as retail wheeling documentation requirements, or Plant Control System (PCS) software used to develop daily merit orders which date from the 1970s • Poorly maintained field equipment to support Operations, such as 40% of Remote Terminal Units (RTUs) being inoperable and out-of-service when LUMA took over operations	• Program installing AGC and metering capability to remaining baseload units • Defined program underway to invest ~$50 million in new EMS • Application of objective non-discriminatory decision-making at all steps in the System Operations process

System Operations Report

<table>
<tr><th>Inherited Conditions</th><th>System Improvements</th></tr>
<tr><td colspan="2">5. Improvement: Awareness and understanding of generation reserve required to operate the BPS within Prudent Utility Practice</td></tr>
<tr><td>• Lack of awareness and consensus on reserve requirements necessary to support policy and regulatory initiatives in Puerto Rico
• Complete lack of awareness of how the reserve deficiencies vary during a 24-hour time frame and throughout the year
• Inability to adequately describe grid stability or risk exposure consistent with North American Electric Reliabiltiy Corporation (NERC) analysis techniques employed by every other System Operations group in the mainland U.S.
• Inability to quantify risks from contingency events to the same degree as most mainland utilities</td><td>• Widely recognized awareness that the Energy Bureau-approved SOP requires 750 MW reserves to comply with NERC and industry guidelines among government and industry stakeholders
• More detailed awareness and understanding of the 24-hour load profile which can now be referenced to validate the economic benefits of demand response, Battery Energy Storage Systems (BESS), and other regulatory policies
• Ability to quantify risks associated with contingency events to develop fact-based mitigation strategies (e.g., Loss of Load Estimates (LOLE), major storms, outage scenarios, others)</td></tr>
<tr><td colspan="2">6. Improvement: Created the first-ever Resource Adequacy Study to quantify generation resource deficiencies and their impact on the BPS</td></tr>
<tr><td>• Poor awareness of quantified Resource Adequacy deficiencies and extent of existing resource gap
• No fact-based models to quantify generator Resource Adequacy deficiencies; instead, numerous plans and reports over the past several years have failed to highlight the existing supply/demand balance and today's resource adequacy deficiencies
• No detailed portfolio analysis capability to adequately explain variations in monthly or quarterly fuel expenditures because of generation availability issues
• Inadequate or inconsistently maintained resource planning models with outdated assumptions (e.g., heat rate, forced outage rates, unit capability)
• Inability to quantify and report portfolio performance to support key decisions and strategies (e.g., load shed risk, reserves, NERC guidelines or industry standards)
• Heavy reliance on external consultants to perform sensitive resource modeling</td><td>• A well-documented and validated assumptions database that reflects current operations that will be used as the base case for the next IRP cycle
• A complete Resource Adequacy report filed with the Energy Bureau that describes the current generation portfolio and provides data and analysis to allow policy makers or developers to understand where to leverage opportunities to create value
• Increasing recognition and awareness by Regulators and Puerto Rican government officials that the resource adequacy deficiencies are a significant issue in Puerto Rico
• A wider pool of personnel inside LUMA using production cost models to evaluate opportunities as they apply to demand-response, energy efficiency, Systems Operations, and IRP support team</td></tr>
</table>

System Operations Report

Inherited Conditions	System Improvements
7. Improvement: Data management practices that enable data-driven decision making	
• Ad-hoc decisions seldom adequately considered costs to the consumer • Lack of validated system operations data to allow even basic utility functions to be adequately optimized (e.g., economic dispatch, outage scheduling scenario analysis) • Poorly trained personnel did not justify their decisions with data analysis so they lacked an understanding of why it was even important because they had never experienced it • Multiple sources of inconsistent information used by different groups inside PREPA/LUMA (e.g., "gross heat rate" vs "net heat rate," "Forced Outage Rates" vs "Forced Outage Factors")	• Consistently applied quality control checks regarding data collection, validation, and reporting • Single, consistently used, central source of data coming from the Energy Management department of System Operations and used for performance reporting, analysis to support regulatory initiatives, dispatch decisions, resource planning and modeling to support fuel cost adjustment filings
8. Improvement: Create new standardized policies and requirements for new generators to interconnect to the system	
• Lack of defined and consistent requirements for new generators to interconnect to the system with many IPPs not even having a signed LGIA • Inconsistent allocation of costs to interconnect and to contract with PREPA resulting in several different developers receiving financial benefits and concessions that had not been made available to all generators	• Consistent, standardized requirements to interconnect with defined approach and documentation requirements publicly available on the LUMA website • Consistent application of costs and documentation requirements applied equally to all generators seeking to interconnect to the system

Appendix C: Issue Escalation by SOP Function

Table C.1 – Issue Escalation by SOP Function between June 1, 2021, and December 31, 2022

#	Transmittals	Escalated To	Type of Issue
1.0	**System Planning**		
1.1	"22.03.02_Response to PREPA Requested Data – Feasibility Study Combined Cycle San Juan (PREB)." LUMA-PREP-T-00188	PREPA Generation Head of the Engineering and Technical Division	Information Exchange
1.2	"22.07.05_Dynamic Modeling Studies RFI." LUMA-PREP-T-00301 "22.12.06_Dynamic Modeling Studies RFI Follow Up." LUMA-PREP-T-00417	PREPA Generation System Operations Director, PREPA Deputy Executive Director	Information Exchange
2.0	**Data Management**		
2.1	"22.05.27_PREPA's Request for Costa Sur Steam Plant Technical Data." LUMA-PREP-T-00258	PREPA Generation System Operations Director	Information Exchange
2.2	"22.06.01_Shared Service Reduction v4" 22.06.07_LUMA-PREP-T-00264	PREPA Executive Director	Non-Compliance
2.3	"22.07.20_PI Data Request." LUMA-PREP-T-00318 "22.08.31_Request for OSI Pi Detailed Fuel Data - Follow Up." LUMA-PREP-T-00348 "22.11.11_Response to PREPA's October 27th Letter Regarding OSI PI Detailed Fuel Data." LUMA-PREP-T-00395	PREPA Deputy Executive Director	Non-Compliance
2.4	"22.10.25_Outstanding Cybersecurity Concerns." LUMA-PREP-T-00382 "22.11.10_Outstanding Cybersecurity Concerns." LUMA-PREP-T-00398 "22.11.28_Outstanding Cybersecurity Concerns." LUMA-PREP-T-00416	PREPA Deputy Executive Director	Non-Compliance
3.0	**Energy Dispatch**		
3.1	"22.03.18_Violation and Non-Compliance Notice Regarding PREPA Adherence to the SOP." LUMA-PREP-T-00198	PREPA Generation Director	Non-Compliance
3.2	"22.03.14_Response to PREPA Request to Access PCS." LUMA-PREP-T-00192 "22.04.22_PREPA Request to Access PCS – Follow Up." LUMA-PREP-T-00212	PREPA Director of Administrative Services	Information Exchange
3.3	"22.04.27_Blackstart and remote start status RFI." LUMA-PREP-T-00230	PREPA Generation System Operations Director	Information Exchange
3.4	"22.06.12_Operation of Hydroelectric Power Plants." LUMA-PREP-T-00278	PREPA Division Head, Hydro Gas and Cambalache Power Plants	Information Exchange
3.5	"22.06.17_Notice of Non-Compliance_System Operations." LUMA-PREP-T-00285	PREPA Generation Director	Non-Compliance
3.6	"22.09.29_Letter to PREPA Regarding Dispatch." LUMA-PREP-T-00368	PREPA Generation Director	Non-Compliance
4.0	**Operating Parameters**		
4.1	"21.11.05_Outstanding Data Requests on System Events." LUMA-PREP-T-00166	PREPA Executive Director	Non-Compliance
4.2	"21.12.22_Outstanding Data on System Events." LUMA-PREP-T-00180	PREPA Executive Director	Non-Compliance
4.3	22.04.07 LUMA-PREP-T-00214, LUMA-PREP-T-00215 "22.04.13_LUMA RFI Follow Up_LUMA-PREP-T-00214 LUMA-PREP-T-00215." LUMA-PREP-T-00219 22.05.02 LUMA-PREP-T-00232 "22.06.03_Costa Sur RFI 5.10 Response Follow Up." LUMA-PREP-T-00267	PREPA Generation System Operations Director	Non-Compliance
4.4	"22.11.30_Disturbance Analysis Follow-Up." LUMA-PREP-T-00418	PREPA Deputy Executive Director	Non-Compliance

System Operations Report

#	Transmittals	Escalated To	Type of Issue
5.0	**Outage Scheduling & Reporting**		
5.1	"21.12.22_Outage Planning & Scheduling." LUMA-PREP-T-00179	PREPA Executive Director	Non-Compliance
5.2	"22.08.19_Aguirre Service Outage." LUMA-PREP-T-00340	PREPA Executive Director	Information Exchange
5.3	"22.12.22 Planned 2023 Outage of AES Unit 2"	AES President	Information Exchange
6.0	**Emergency Response**		
6.1	"22.08.17_Emergency Operations Center Access Response." LUMA-PREP-T-00339	PREPA Executive Director	Information Exchange
7.0	**Balancing Frequency and System Impacts**		
7.1	"22.03.25_Notice of Non-Compliance_System Operations." LUMA-PREP-T-00203	PREPA Generation Director	Non-Compliance
7.2	"22.09.08_Notice of Non-Compliance System Events." LUMA-PREP-T-00355	PREPA Director of Generation	Non-Compliance
7.3	"22.09.09_Frequency Excursion." LUMA-PREP-T-00185	PREPA Generation Director	Information Exchange
7.4	"22.11.11_LUMA Response to PREPA Letter Re System Frequency Excursion." LUMA-PREP-T-00400	PREPA Executive Director	Information Exchange
8.0	**Other System-Related Topics**		
8.1	"2022-05-02 LUMA Letter to Josué Colón re Preliminary Report"	PREPA Executive Director	Non-Compliance
8.2	"22.06.18_PREPAs Cooperation and Responsiveness on Important Matters." LUMA-PREP-T-00293 "22.06.29_PREPA Compliance with T&D System Contracts." LUMA-PREP-T-00298	PREPA Executive Director	Non-Compliance
8.3	"22.08.26 LUMA Response to AES"	AES President	Information Exchange
8.4	"22.12.20_August 22, 2021, Incident Documentation Request." LUMA-PREP-T-00431	PREPA Executive Director	Non-Compliance
8.5	"22.12.23_PREPA Request for Transformer Documentation." LUMA-PREP-T-00436	PREPA Director of Generation	Information Exchange

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Generation Performance Report

June 1, 2021 – December 31, 2022

Introduction

As part of the Transmission and Distribution System Operation and Maintenance Agreement (OMA), LUMA serves as both the operator of the electric grid and as the island's System Operator.

As the Operator of the electric grid, LUMA oversees and maintains the transmission and distribution system that is critical to delivering energy to over 1.5 million Puerto Rican customers.

As the System Operator, LUMA monitors the performance of the Puerto Rico Electric Power Authority (PREPA) and other private generators' generation units, implements dispatch of available units, and plans and maintains adequate generation reserve levels to meet customer's energy demands.

While LUMA does not generate energy, LUMA's responsibility as the System Operator includes measuring the performance of the island's generation fleet. This report summarizes generation performance, identifies trends, compares facility performance, and provides a high-level picture of the entire generation portfolio.

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  - Planned Outage Hours
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- Fuel Production Costs

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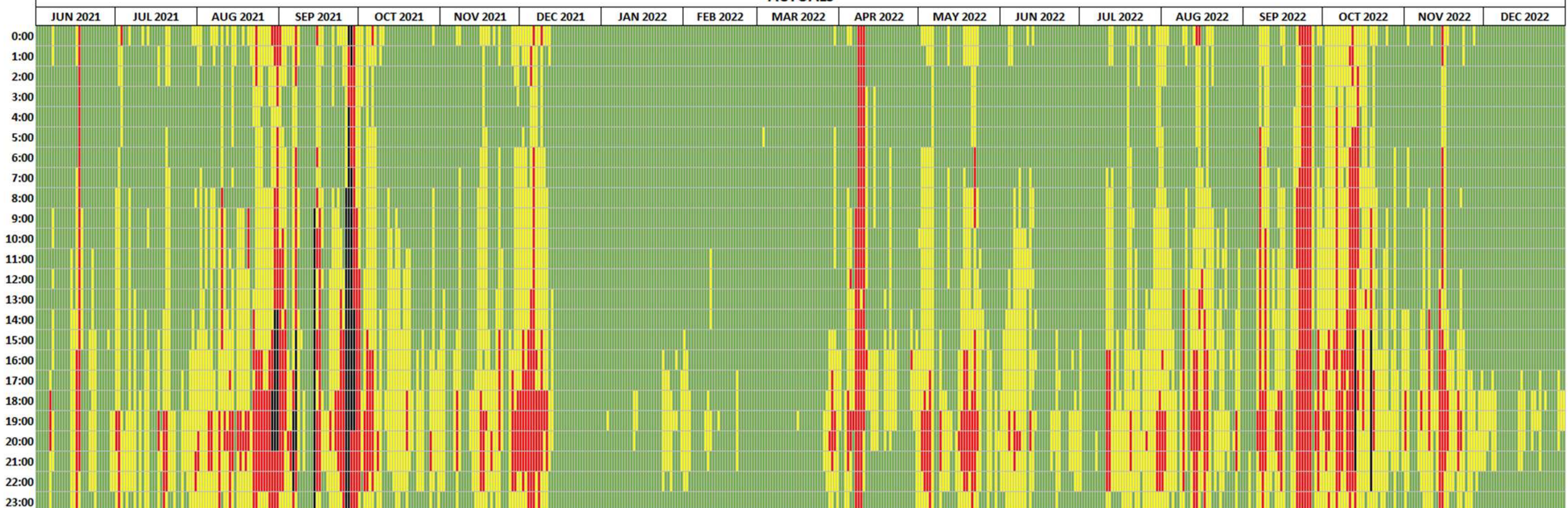
System Reserves

System Reserves is the amount of generating capacity available to meet peak or abnormally high demands for power and to generate power during scheduled or unscheduled outages.

Target: ▲ Reserves >750MW per the System Operation Principles

ACTUALS



	JUN 2021	JUL 2021	AUG 2021	SEP 2021	OCT 2021	NOV 2021	DEC 2021	JAN 2022	FEB 2022	MAR 2022	APR 2022	MAY 2022	JUN 2022	JUL 2022	AUG 2022	SEP 2022	OCT 2022	NOV 2022	DEC 2022
Reserves Average (MW)	997	873	631	616	808	880	1038	1292	1208	1241	858	783	907	842	777	686	599	828	1084
Hours below 750 MW	128	231	491	443	323	269	244	36	37	52	227	316	192	273	340	411	545	245	50

Green	>750 MW
Yellow	400-750 MW
Red	<450 MW
Black	Shortfall

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

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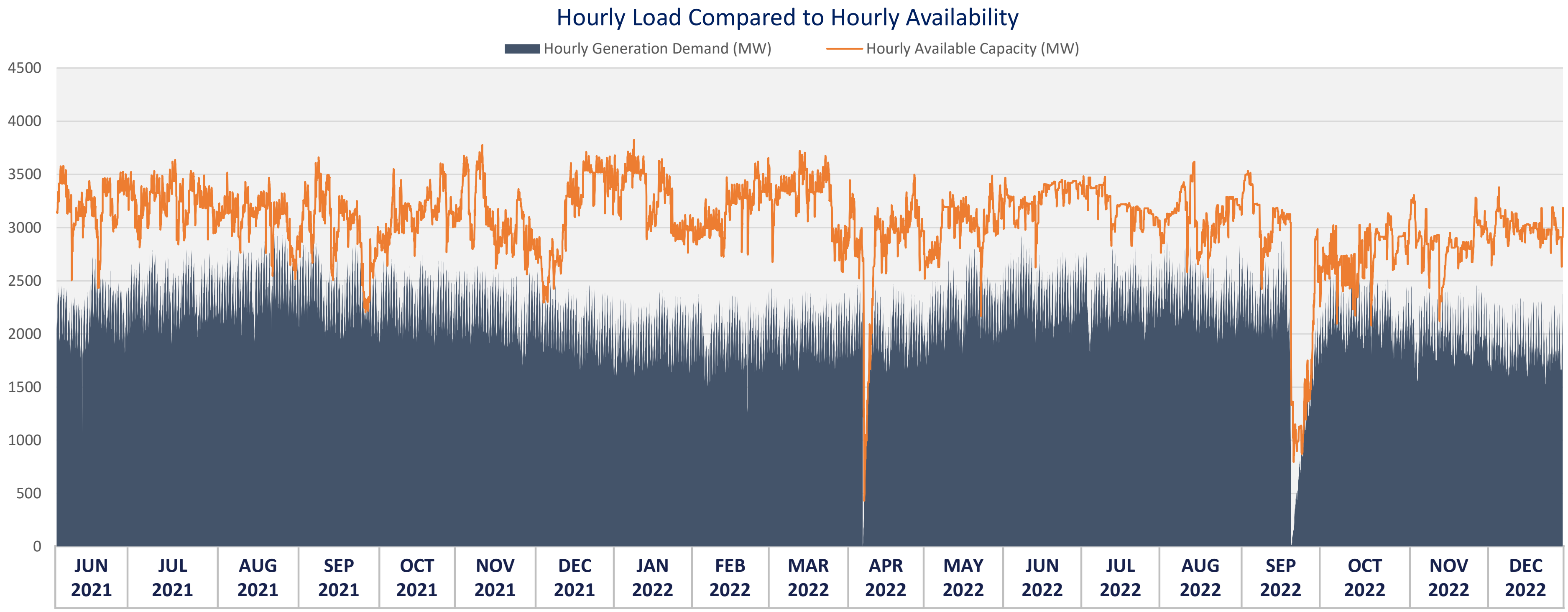
System Availability

The System Availability is the maximum expected output that generating units can supply to system load, adjusted for scheduled or unscheduled outages. In this graph, the availability is being compared with the total generation required to meet demand to visualize the gap between the two lines (the gap represents the reserves level).

Target: ▲ A bigger gap between availability and generation demand means a better chance of recovery in emergency events due to adequate reserves.

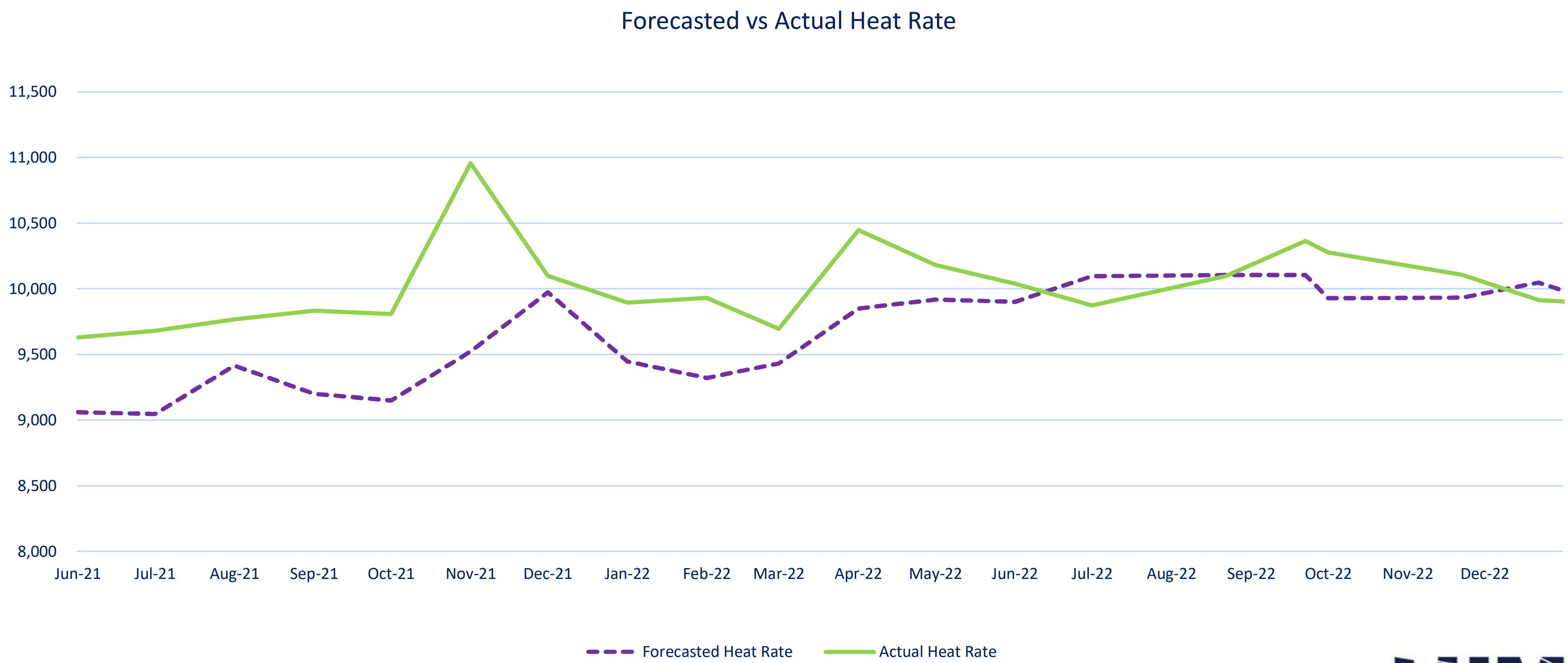


*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

System Heat Rate

The System Heat Rate measures the efficiency of the system to convert fuel into electricity. System Heat Rate will vary depending on the available generation units and required resources to satisfy electrical demand. It is calculated as energy consumed (MMBtu) / energy produced (MWh). The forecasted Heat Rate is determined by the last forecast calculated for the Fuel Clause Adjustment Factor.

Target: ▼ Lower heat rates represent higher efficiency.



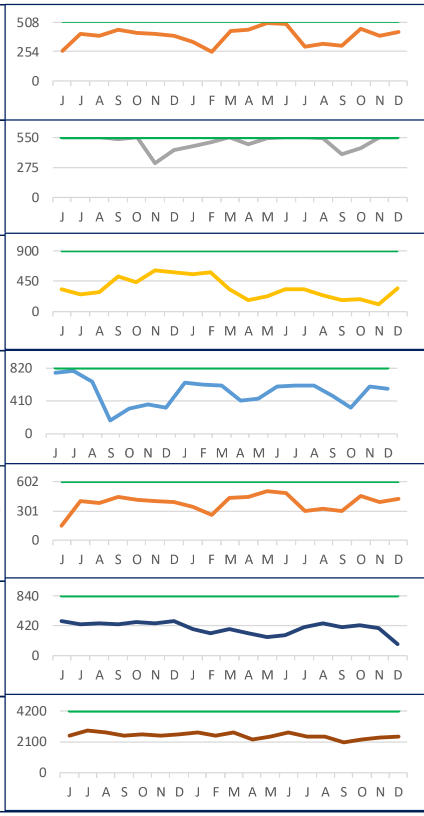
*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Available Capacity – Baseload Units

Available Capacity is the maximum output that a unit can generate at any given time. The Availability Rate indicates the percent of available capacity out of the total nameplate capacity. Variables in the chart below are shown in MW (gross) representing an average over the month.

Target: ▲ A higher availability indicates the plant is able to produce power closer to its nameplate capacity.

Available Capacity (MW) and Availability Rate (AR)



Unit		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES	MW	263	404	388	443	414	405	389	338	257	437	443	505	490	298	321	302	452	391	426
Nameplate Cap: 508	AR	52%	80%	76%	87%	82%	80%	77%	67%	51%	86%	87%	99%	97%	59%	63%	59%	89%	77%	84%
EcoElectrica	MW	550	550	550	532	550	312	437	475	508	550	486	546	550	550	547	395	452	550	550
Nameplate Cap: 550	AR	100%	100%	100%	97%	100%	57%	80%	86%	92%	100%	88%	99%	100%	100%	99%	72%	82%	100%	100%
PREPA Aguirre	MW	324	263	291	520	439	606	582	556	576	326	170	225	328	327	249	175	180	107	350
Nameplate Cap: 900	AR	36%	29%	32%	58%	49%	67%	65%	62%	64%	36%	19%	25%	36%	36%	28%	19%	20%	12%	39%
PREPA Costa Sur	MW	757	785	653	157	316	367	324	635	608	605	408	443	587	599	598	477	324	586	568
Nameplate Cap: 820	AR	92%	96%	80%	19%	39%	45%	40%	77%	74%	74%	50%	54%	72%	73%	73%	58%	40%	71%	69%
PREPA Palo Seco	MW	149	404	388	443	414	405	389	338	257	437	443	505	490	298	321	302	452	391	426
Nameplate Cap: 602	AR	25%	67%	64%	74%	69%	67%	65%	56%	43%	73%	74%	84%	81%	50%	53%	50%	75%	65%	71%
PREPA San Juan	MW	481	446	460	437	470	459	476	365	314	365	312	255	283	394	454	403	427	385	167
Nameplate Cap: 840	AR	57%	53%	55%	52%	56%	55%	57%	43%	37%	43%	37%	30%	34%	47%	54%	48%	51%	46%	20%
Total Baseload	MW	2524	2852	2730	2532	2604	2554	2598	2708	2521	2718	2263	2479	2728	2467	2490	2054	2287	2410	2488
Nameplate Cap: 4220	AR	60%	68%	65%	60%	62%	61%	62%	64%	60%	64%	54%	59%	65%	58%	59%	49%	54%	57%	59%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Available Capacity – Peaker Units

Available Capacity is the maximum output that a unit can generate at any given time. The Availability Rate indicates the percent of available capacity out of the total nameplate capacity. Variables in the chart below are shown in MW representing an average over the month.

Target: ▲ A higher availability indicates the plant is able to produce power closer to its nameplate capacity.

Available Capacity (MW) and Availability Rate (AR)

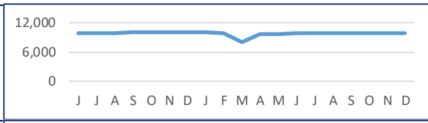
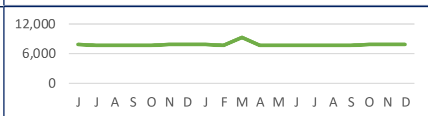
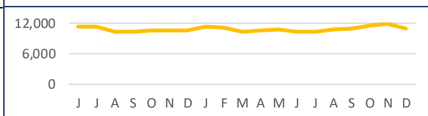
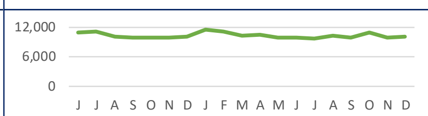
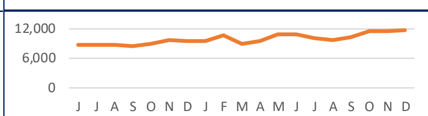
Unit		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
PREPA Aguirre Combined Cycle	MW	232	160	125	269	236	204	194	193	213	240	184	246	278	201	236	171	202	166	65
Nameplate Cap: 592	AR	39%	27%	21%	45%	40%	34%	33%	33%	36%	41%	31%	42%	47%	34%	40%	29%	34%	28%	11%
PREPA Cambalache	MW	154	114	124	130	155	155	152	151	151	151	125	77	118	143	134	146	152	146	156
Nameplate Cap: 248	AR	62%	46%	50%	53%	63%	63%	61%	61%	61%	61%	50%	31%	48%	58%	54%	59%	62%	59%	63%
PREPA Mayaguez	MW	39	40	39	36	29	35	38	40	38	40	41	30	40	38	38	37	37	29	37
Nameplate Cap: 220	AR	18%	18%	18%	17%	13%	16%	17%	18%	17%	18%	18%	14%	18%	17%	17%	17%	17%	13%	17%
PREPA Palo Seco (Inc. Mobile-Pack)	MW	123	119	110	120	125	129	129	133	150	150	155	146	155	153	122	148	175	177	170
Nameplate Cap: 207	AR	60%	58%	53%	58%	60%	62%	63%	64%	73%	73%	75%	70%	75%	74%	59%	71%	84%	85%	82%
Other Peakers	MW	91	64	67	70	79	93	92	81	97	88	71	94	67	91	89	68	68	71	73
Nameplate Cap: 264	AR	34%	24%	25%	27%	30%	35%	35%	31%	37%	33%	27%	36%	25%	34%	34%	26%	26%	27%	28%
Total Peakers	MW	640	498	465	626	624	617	605	598	650	670	575	593	658	626	618	569	634	589	501
Nameplate Cap: 1531	AR	42%	33%	30%	41%	41%	40%	40%	39%	42%	44%	38%	39%	43%	41%	40%	37%	41%	38%	33%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Heat Rate – Baseload Units

Heat Rate measures the efficiency of a power plant to convert fuel into electricity. It is calculated as energy consumed (MMBtu) / energy produced (MWh).

Target: ▼ Lower heat rates represent higher efficiency.

	Heat Rate (MMBtu/MWh)	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES		9,809	9,833	9,905	9,957	9,987	10,019	10,003	9,964	9,826	8,104	9,726	9,694	9,766	9,800	9,800	9,800	9,800	9,800	9,800
EcoElectrica		7,798	7,739	7,596	7,714	7,623	7,905	7,819	7,848	7,719	9,182	7,718	7,739	7,692	7,683	7,683	7,683	7,932	7,932	7,932
PREPA Aguirre		11,306	11,382	10,454	10,475	10,590	10,540	10,569	11,362	11,103	10,406	10,610	10,767	10,362	10,366	10,847	10,935	11,486	12,016	10,957
PREPA Costa Sur		11,195	11,065	10,656	10,681	10,603	10,393	10,825	11,712	11,471	10,778	10,899	10,791	10,362	10,447	10,620	10,749	10,724	10,736	10,845
PREPA Palo Seco		10,920	11,087	10,038	9,952	9,829	9,957	10,073	11,413	11,128	10,337	10,403	9,840	9,839	9,738	10,249	9,865	10,960	9,876	10,131
PREPA San Juan		8,597	8,728	8,584	8,410	8,824	9,627	9,474	9,375	10,596	8,836	9,369	10,872	10,768	10,102	9,662	10,271	11,417	11,404	11,603
Total Baseload		9,757	9,813	9,379	9,448	9,436	9,303	9,396	9,843	9,778	9,500	9,597	9,769	9,705	9,633	9,712	9,846	10,156	10,049	9,982

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Heat Rate – Peaker Units

Heat Rate measures the efficiency of a power plant to convert fuel into electricity. It is calculated as energy consumed (MMBtu) / energy produced (MWh).

Target: ▼ Lower heat rates represent higher efficiency.

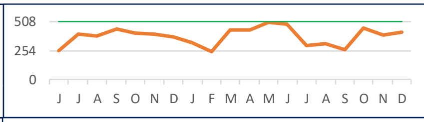
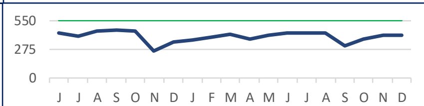
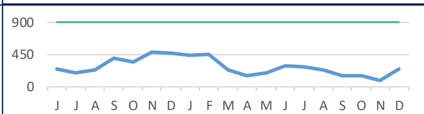
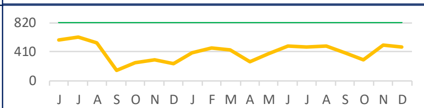
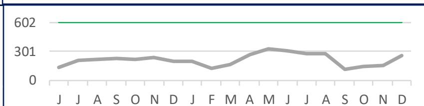
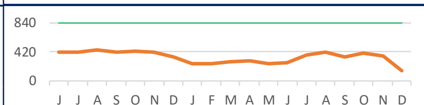
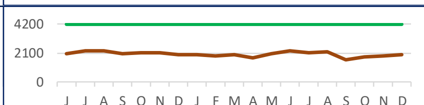
	Heat Rate (MMBtu/MWh)	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
PREPA Aguirre Combined Cycle		13,293	14,588	14,396	13,124	13,534	15,387	14,605	15,835	15,535	13,071	14,686	14,316	13,796	11,602	12,169	13,170	12,150	13,145	15,978
PREPA Cambalache		12,813	12,704	12,372	12,072	12,776	12,878	12,528	14,830	13,699	13,059	12,450	13,005	13,117	13,001	12,530	12,481	12,646	13,185	14,794
PREPA Mayaguez		10,865	10,317	10,442	10,593	10,958	9,816	10,498	10,945	10,333	10,599	10,626	10,878	10,557	10,552	10,406	10,728	13,418	10,919	10,413
PREPA Palo Seco (Inc. Mobile Pack)		15,342	15,679	15,432	15,609	15,916	15,804	15,822	16,219	14,904	15,548	15,556	16,687	15,226	19,157	15,922	12,234	11,818	11,481	11,719
Other Peakers		15,187	15,083	14,935	12,150	10,710	15,230	14,979	15,313	15,458	15,381	15,082	14,951	15,888	13,496	15,487	14,860	15,750	14,053	15,681
Total Peakers		13,089	13,567	13,164	12,629	12,849	13,736	13,787	15,131	14,692	12,950	13,394	13,501	13,306	11,936	12,319	12,421	12,587	12,438	12,628

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Generation and Capacity Factor – Baseload Units

Generation indicates the average amount of energy each plant produced per month, in MW (gross). The Capacity Factor measures what percentage of the nameplate capacity was used to produce energy during that time period.

Target: ▲ Higher Capacity Factor, and a Generation closer to the nameplate capacity will represent a better utilization of the units.

Unit	Average Generation (MW) and Capacity Factor		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES		MW	258	399	386	443	412	399	378	319	250	431	435	504	488	296	318	266	452	390	414
Nameplate Cap: 508		CF	51%	78%	76%	87%	81%	79%	74%	63%	49%	85%	86%	99%	96%	58%	63%	52%	89%	77%	82%
EcoElectrica		MW	431	401	446	455	451	265	345	361	393	423	372	409	428	433	428	309	373	416	411
Nameplate Cap: 550		CF	78%	73%	81%	83%	82%	48%	63%	66%	71%	77%	68%	74%	78%	79%	78%	56%	68%	76%	75%
PREPA Aguirre		MW	246	194	232	401	337	474	464	442	448	239	146	194	287	281	231	155	145	83	250
Nameplate Cap: 900		CF	27%	22%	26%	45%	37%	53%	52%	49%	50%	27%	16%	22%	32%	31%	26%	17%	16%	9%	28%
PREPA Costa Sur		MW	575	615	539	140	254	295	248	389	460	442	262	377	495	473	498	400	299	503	471
Nameplate Cap: 820		CF	70%	75%	66%	17%	31%	36%	30%	47%	56%	54%	32%	46%	60%	58%	61%	49%	37%	61%	57%
PREPA Palo Seco		MW	140	211	219	224	221	242	196	194	122	167	270	326	305	277	275	114	149	152	258
Nameplate Cap: 602		CF	23%	35%	36%	37%	37%	40%	33%	32%	20%	28%	45%	54%	51%	46%	46%	19%	25%	25%	43%
PREPA San Juan		MW	412	417	443	413	430	414	348	247	246	280	285	242	262	374	419	353	404	365	141
Nameplate Cap: 840		CF	49%	50%	53%	49%	51%	49%	41%	29%	29%	33%	34%	29%	31%	45%	50%	42%	48%	43%	17%
Total Baseload		MW	2063	2237	2266	2076	2105	2090	1979	1951	1919	1983	1771	2054	2265	2134	2169	1597	1822	1910	1945
Nameplate Cap: 4220		CF	49%	53%	54%	49%	50%	50%	47%	46%	45%	47%	42%	49%	54%	51%	51%	38%	43%	45%	46%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Generation and Capacity Factor – Peaker Units

Generation indicates the average amount of energy each plant produced per month (MW). The Capacity Factor measures what percentage of the nameplate capacity was used to produce energy during that time period.

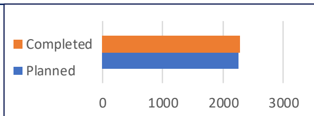
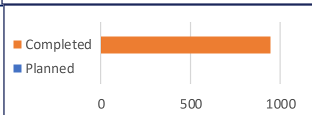
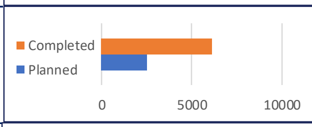
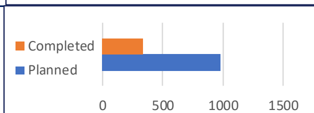
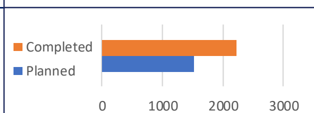
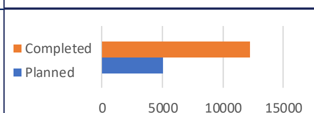
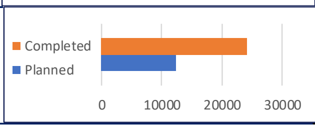
Target: ▲Higher Capacity Factor, and a Generation closer to the nameplate capacity will represent a better utilization of the units.

Average Generation (MW) and Capacity Factor

Unit		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
PREPA Aguirre Combined Cycle	MW	80	65	70	161	108	74	67	27	28	33	76	114	92	100	113	80	149	76	5
Nameplate Cap: 592	CF	14%	11%	12%	27%	18%	12%	11%	5%	5%	6%	13%	19%	15%	17%	19%	14%	25%	13%	1%
PREPA Cambalache	MW	26	28	63	63	52	35	24	3	6	10	33	25	17	16	35	63	53	22	10
Nameplate Cap: 247.5	CF	11%	11%	25%	26%	21%	14%	10%	1%	2%	4%	13%	10%	7%	6%	14%	25%	21%	9%	4%
PREPA Mayaguez	MW	23	23	41	51	35	23	18	3	3	6	38	42	22	26	29	53	46	51	18
Nameplate Cap: 220	CF	11%	11%	19%	23%	16%	11%	8%	2%	1%	3%	17%	19%	10%	12%	13%	24%	21%	23%	8%
PREPA Palo Seco (Inc. Mobile-Pack)	MW	11	9	17	19	7	7	7	2	1	1	9	2	5	7	7	39	62	21	4
Nameplate Cap: 207	CF	5%	4%	8%	9%	3%	3%	3%	1%	1%	1%	4%	1%	2%	3%	3%	19%	30%	10%	2%
Other Peakers (PREPA)	MW	11	10	21	34	18	17	15	2	3	2	12	15	4	3	12	14	23	16	2
Nameplate Cap: 264	CF	4%	4%	8%	13%	7%	6%	6%	1%	1%	1%	4%	6%	2%	1%	5%	5%	9%	6%	1%
Total Peakers	MW	152	135	211	328	221	156	130	37	42	53	167	198	140	151	196	249	332	186	39
Nameplate Cap: 1530.5	CF	10%	9%	14%	21%	14%	10%	8%	2%	3%	3%	11%	13%	9%	10%	13%	16%	22%	12%	3%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Planned Outage Hours – Baseload Units

	Planned Outage Hours (JUN 2021 - DEC 2022)	Planned Outage Hours	Completed Outage Hours
AES		**2256**	**2280**
EcoElectrica		**0**	**943**
PREPA Aguirre		**2496**	**6130**
PREPA Costa Sur		**984**	**340**
PREPA Palo Seco		**1512**	**2218**
PREPA San Juan		**5040**	**12182**
Total Baseload		**12288**	**24092**

Planned Outage Hours represents the shutdown of a generating unit or facility for inspection or maintenance, in accordance with an advance schedule; represented in hours. This scoreboard compares the scheduled outage hours with the actual duration of the outage.

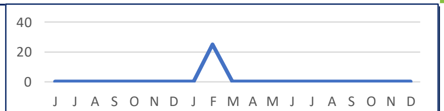
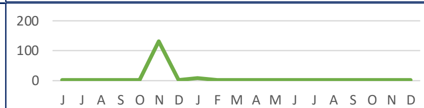
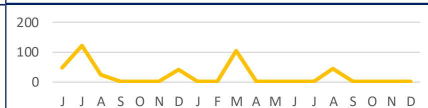
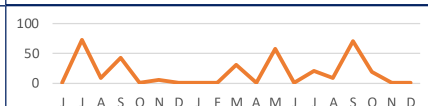
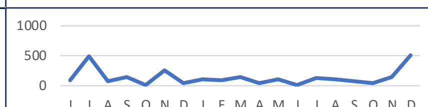
Target: ▼ A smaller gap between actuals and planned hours represents a more accurate planification.

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Maintenance Outage Hours – Baseload Units

Maintenance Outage Hours represent the shutdown of a generating unit or facility for nonemergency reasons or conditions which need repair outside of the advance schedule; represented in hours per unit.

Target: ▼ Less maintenance hours represents more available capacity in the system to meet demand.

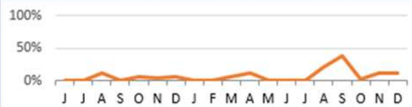
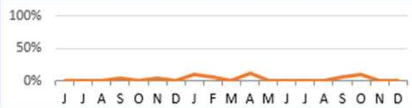
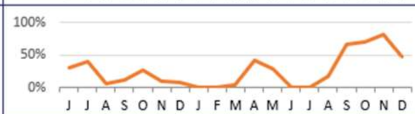
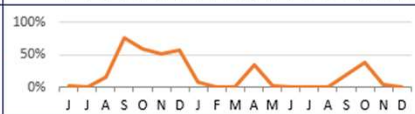
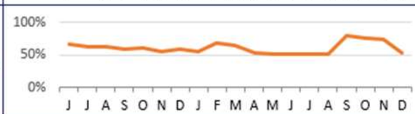
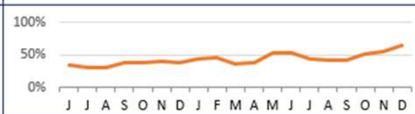
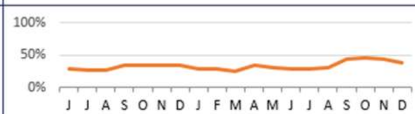
	Maintenance Outage Hours	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES		0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0
EcoElectrica		0	0	0	0	0	131	0	7	0	0	0	0	0	0	0	0	3	0	0
PREPA Aguirre		48	120	24	0	0	0	43	0	0	103	0	0	0	0	43	0	0	0	0
PREPA Costa Sur		0	18	0	0	0	0	0	94	0	0	0	48	3	0	37	0	0	0	90
PREPA Palo Seco		0	73	9	42	0	5	0	0	0	31	0	57	0	21	9	71	18	0	0
PREPA San Juan		38	281	43	96	0	120	0	0	66	0	41	0	0	98	15	0	19	137	421
Total Baseload		86	492	76	138	0	256	43	101	91	135	41	105	3	119	104	71	40	137	511

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Forced Outage Hours and Rate – Baseload Units

Forced Outage Hours represent the shutdown of a generating unit or facility for emergency reasons or a condition in which the generating equipment is unavailable for load due to an unanticipated breakdown; represented in hours per unit. The Forced Outage Rate represents the percentage of time the unit was in a Forced Outage condition out of the total time the unit was expected to be available.

Target: ▼ Less forced outage hours and a smaller outage rate represents more available capacity in the system to meet demand.

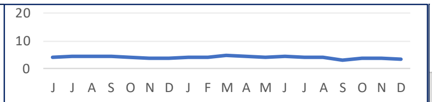
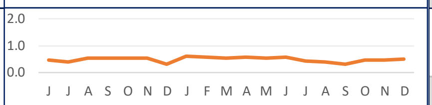
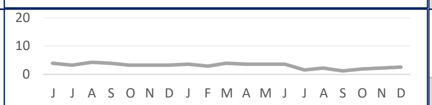
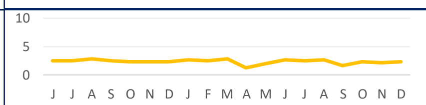
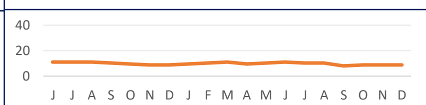
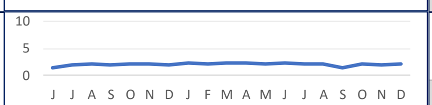
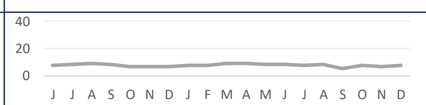
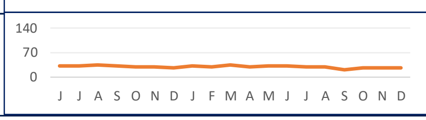
Forced Outage Hours and Outage Rate			Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES		Hrs	3	0	169	0	75	63	97	0	2	100	161	0	0	0	281	543	36	175	178
		%	0%	0%	11%	0%	5%	4%	6%	0%	0%	7%	11%	0%	0%	0%	21%	38%	2%	12%	12%
EcoElectrica		Hrs	7	0	0	68	0	46	13	199	104	0	256	16	0	0	7	118	211	0	4
		%	0%	0%	0%	3%	0%	3%	1%	9%	5%	0%	12%	1%	0%	0%	0%	5%	10%	0%	0%
PREPA Aguirre		Hrs	330	377	47	144	398	151	112	0	2	28	320	213	0	0	130	899	1055	1180	720
		%	31%	39%	6%	11%	27%	11%	8%	0%	0%	4%	43%	29%	0%	0%	16%	67%	71%	82%	48%
PREPA Costa Sur		Hrs	25	0	217	1104	884	740	844	96	9	0	475	19	14	0	2	268	553	46	0
		%	2%	0%	15%	77%	59%	51%	57%	7%	1%	0%	35%	2%	1%	0%	0%	19%	37%	3%	0%
PREPA Palo Seco		Hrs	1465	1806	1849	1647	1817	1562	1744	1503	1384	1551	1543	1487	1482	1492	1507	2198	2250	2120	1572
		%	67%	62%	62%	58%	62%	54%	59%	54%	69%	64%	54%	51%	51%	50%	51%	80%	77%	74%	53%
PREPA San Juan		Hrs	1645	1536	1555	2096	2178	2190	2312	2256	1823	1601	1634	2230	2196	2574	2530	2432	3000	3071	2930
		%	34%	31%	30%	38%	37%	39%	39%	44%	46%	36%	39%	54%	53%	44%	43%	42%	51%	55%	64%
Total Baseload		Hrs	3474	3719	3839	5059	5352	4753	5121	4055	3324	3280	4390	3965	3691	4066	4455	6458	7105	6592	5405
		%	28%	27%	27%	35%	35%	34%	34%	29%	29%	26%	34%	31%	29%	29%	30%	43%	46%	44%	38%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Renewables Capacity Factor - Solar

The Capacity Factor measures the actual production of electricity over the theoretical maximum output (nameplate capacity). For Renewable projects, the Capacity Factor is expected to be lower due to the solar and wind cycles.

Target: ▲ A higher Capacity Factor represents a better utilization of the maximum capacity the project is able to produce.

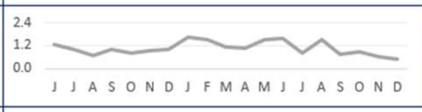
Project	Average Production (MW) and Capacity Factor		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
AES Ilumina		MW	4	5	4	4	4	4	4	4	4	5	4	4	4	4	4	3	4	4	3
Nameplate Cap: 20		CF	21%	23%	22%	22%	20%	18%	19%	21%	21%	24%	22%	21%	22%	21%	21%	16%	19%	18%	17%
Windmar Cantera Martinó		MW	0.4	0.4	0.5	0.5	0.5	0.5	0.3	0.6	0.6	0.5	0.6	0.5	0.6	0.4	0.4	0.3	0.5	0.4	0.5
Nameplate Cap: 2.1		CF	21%	18%	25%	24%	25%	25%	14%	28%	27%	25%	27%	25%	27%	20%	17%	15%	22%	21%	23%
San Fermín		MW	4	3	4	4	3	3	3	3	3	4	3	3	3	1	2	1	2	2	2
Nameplate Cap: 20		CF	19%	15%	20%	18%	15%	16%	15%	17%	14%	19%	17%	17%	17%	7%	10%	6%	8%	10%	12%
Horizon Energy		MW	3	3	3	3	2	2	2	3	3	3	1	2	3	2	3	2	2	2	2
Nameplate Cap: 10		CF	25%	25%	28%	26%	24%	23%	23%	27%	25%	28%	14%	20%	27%	25%	27%	17%	23%	22%	23%
Oriana Energy		MW	11	11	11	11	9	9	9	10	10	11	10	10	11	10	10	8	9	9	9
Nameplate Cap: 45		CF	24%	24%	25%	24%	21%	20%	19%	22%	22%	24%	21%	23%	24%	23%	23%	17%	19%	20%	20%
Windmar Coto Laurel		MW	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2
Nameplate Cap: 10		CF	14%	19%	21%	20%	22%	21%	21%	23%	21%	24%	23%	22%	23%	21%	21%	14%	21%	20%	22%
Fonroche Humacao		MW	7	8	9	8	7	7	7	8	8	9	9	8	8	7	8	5	7	7	7
Nameplate Cap: 40		CF	18%	20%	22%	20%	17%	17%	16%	19%	19%	22%	22%	19%	20%	19%	20%	14%	18%	17%	18%
Total Solar		MW	31	31	34	32	28	28	27	30	30	34	30	31	32	28	30	21	26	26	27
Nameplate Cap: 147		CF	21%	21%	23%	22%	19%	19%	18%	21%	20%	23%	20%	21%	22%	19%	20%	14%	18%	18%	18%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Renewables Capacity Factor – Wind and Landfill

The Capacity Factor measures the actual production of electricity over the theoretical maximum output (nameplate capacity). For Renewable projects, the Capacity Factor is expected to be lower due to the solar and wind cycles.

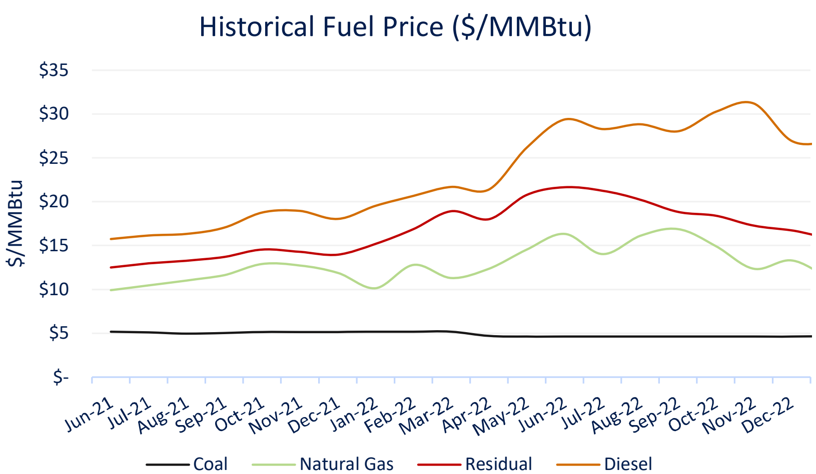
Target: ▲ A higher Capacity Factor represents a better utilization of the maximum capacity the project is able to produce.

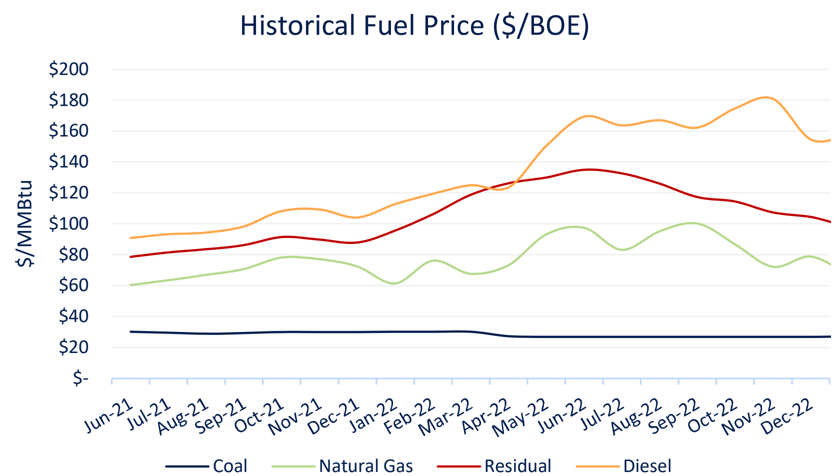
	Average Production (MW) and Capacity Factor		Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Pattern Santa Isabel		MW	24	30	22	10	11	13	16	16	19	25	24	24	24	26	18	7	10	10	11
Nameplate Cap: 75		CF	32%	41%	29%	14%	14%	17%	21%	21%	25%	33%	33%	32%	32%	35%	25%	9%	13%	13%	14%
Landfill Gas Fajardo		MW	0.4	0.5	0.5	0.5	0.5	0.4	0.6	0.4	0.5	0.8	0.4	0.6	0.8	0.3	0.6	0.4	0.1	0.2	0.4
Nameplate Cap: 2.4		CF	18%	21%	21%	21%	21%	15%	24%	16%	21%	33%	18%	24%	33%	14%	25%	16%	6%	9%	18%
Landfill Gas Toa Baja		MW	1.2	1.0	0.7	1.0	0.8	1.0	1.0	1.7	1.5	1.2	1.1	1.5	1.6	0.8	1.5	0.7	0.9	0.6	0.5
Nameplate Cap: 2.4		CF	51%	41%	29%	42%	33%	40%	41%	69%	63%	48%	44%	64%	65%	33%	62%	31%	36%	26%	21%
Total Wind and Landfill		MW	26	32	23	12	12	14	18	18	21	27	26	26	26	27	20	8	11	11	12
Nameplate Cap: 80		CF	32%	40%	29%	15%	15%	17%	22%	22%	26%	34%	32%	32%	33%	34%	26%	10%	14%	14%	14%

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Fuel Prices

Fuel Price shows the prices paid for fuel used by PREPA and private generators, both in terms of MMBtus and Barrel of Oil Equivalent (BOE). The Fuel Price is divided by Fuel Type to better illustrate the contribution to the total Fuel Price for the month.



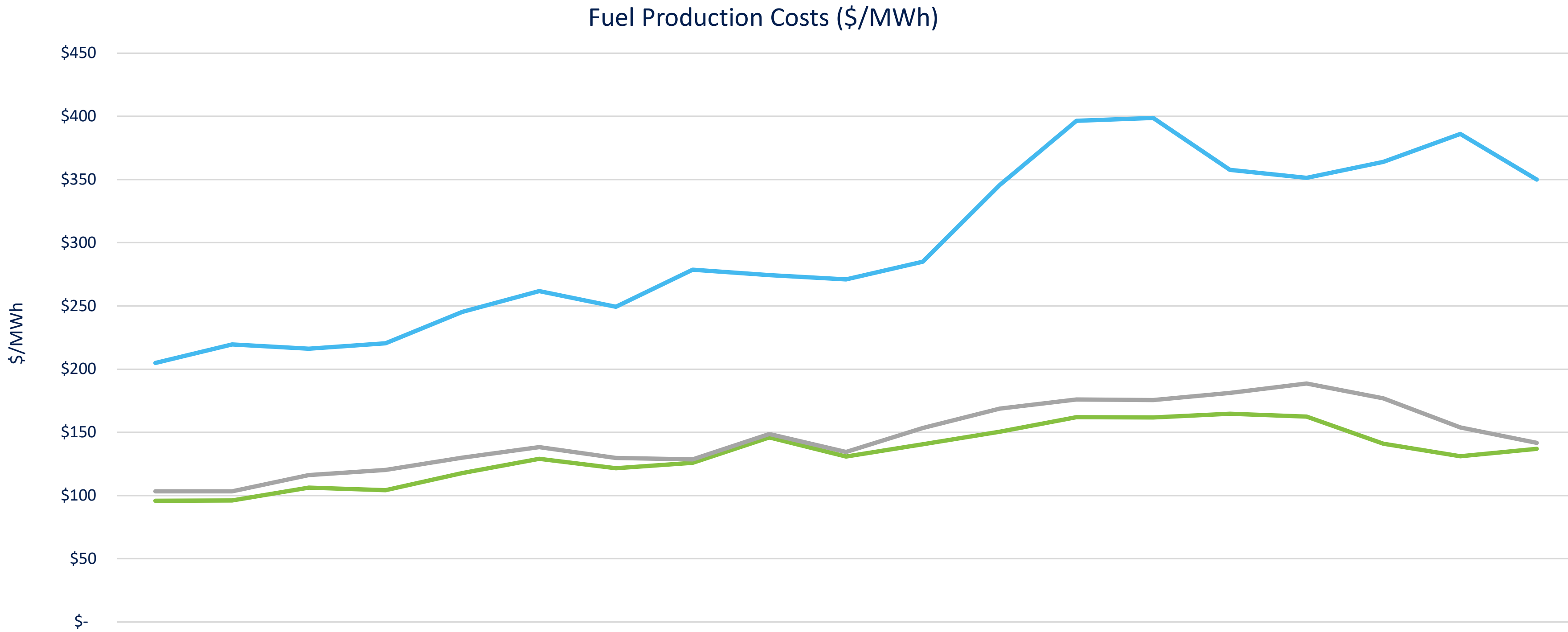


	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
$/MMBtu																			
Diesel	15.76	16.16	16.34	17.05	18.77	18.95	18.04	19.53	20.68	21.69	21.41	26.17	29.37	30.23	31.20	26.95	26.77	26.93	25.60
Residual	12.50	12.98	13.28	13.71	14.56	14.29	13.98	15.20	16.89	18.93	18.03	20.78	21.64	18.41	17.26	16.75	15.98	16.67	15.62
Natural Gas	9.94	10.46	11.03	11.65	12.93	12.74	11.91	10.16	12.81	11.32	12.38	14.54	16.35	14.94	12.35	13.32	11.36	10.02	9.19
Coal	5.18	5.11	4.97	5.04	5.17	5.16	5.16	5.18	5.20	5.20	4.70	4.63	4.63	4.63	4.62	4.62	4.68	4.68	4.73
$/BOE																			
Diesel	90.92	93.23	94.29	98.37	108.30	109.34	104.09	112.68	119.33	124.91	123.56	150.39	169.30	174.68	180.89	154.70	156.31	155.24	148.87
Residual	78.58	81.59	83.51	86.17	91.51	89.82	87.89	95.55	106.20	118.78	126.14	129.91	135.01	114.41	107.37	104.42	99.14	102.69	97.22
Natural Gas	60.34	63.51	66.92	70.70	78.21	77.09	72.38	61.44	76.05	67.71	73.28	93.17	97.47	86.67	72.11	78.82	67.47	58.05	54.41
Coal	30.04	29.61	28.83	29.27	29.97	29.95	29.96	30.08	30.14	30.15	27.28	26.83	26.83	26.83	26.83	26.83	27.14	27.16	27.43

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Fuel Production Costs

Variable Production Costs are predominantly fuel costs and reflect the cost to produce one MWh of energy. In the graph, the cost is shown separately for Baseload units and Peaker units. The weighted average cost indicates the cost per MWh of energy produced for the System Portfolio.



	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Baseload Prod. Cost	$96	$96	$106	$104	$118	$129	$122	$126	$146	$131	$141	$151	$162	$162	$165	$162	$141	$131	$137
Peaker Prod. Cost	$205	$220	$216	$221	$245	$262	$249	$279	$274	$271	$285	$346	$397	$399	$358	$351	$364	$386	$350
Weighted Prod. Costs	$103	$103	$116	$120	$130	$138	$130	$129	$149	$134	$153	$169	$176	$176	$181	$189	$177	$154	$142

Baseload Prod. Cost — Peaker Prod. Cost — Weighted Prod. Costs

*Refer to Glossary of Terms on page 20 for a list of definitions and formulas.

Glossary of Terms

Term	Definition	Formula
Heat Rate	Measures the efficiency of a power plant to convert fuel into electricity. It is the amount of energy used by a power plant to generate one kilowatt-hour (kWh) of electricity. The more efficient the generator is, the lower the heat rate.	MMBtu consumption by all units in the station during a specific period / MWh produced by the same units in the same period
Reserves	Amount of generating capacity available to meet peak or abnormally high demands for power and to generate power during scheduled or unscheduled outages.	Available Capacity (MW) during the reported period minus the Actual Generation (MW) during the same period
Available Capacity	The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for scheduled or unscheduled outages.	N/A – value is provided for each unit
Availability Rate	The ratio of the maximum output that can be supplied to system load for the period of time considered to the nameplate capacity.	Average available capacity for a specific period (MW) / nameplate capacity
Production	The amount of electric energy produced.	N/A – value is provided for each unit
Capacity Factor	The ratio of the electrical energy produced by a generating unit for the period of time considered to the nameplate capacity.	The average energy produced by all units in the plant during a specific period (MWh) / Nameplate capacity for the plant
Planned Outage Hours	The shutdown of a generating unit or facility for inspection or maintenance, in accordance with an advance schedule; represented in hours per unit (Equivalent Planned Outage Hours). Planned Hours – hours provided in the Generation Outage Schedule for the following 90-day outlook. Actual Hours – number of hours a unit was out of service due to a planned outage.	N/A – values is provided for each unit
Maintenance Outage Hours	The shutdown of a generating unit or facility for nonemergency reasons or conditions which need repair outside of the advance schedule; represented in hours per unit.	N/A – value is provided for each unit
Forced Outage Hours	The shutdown of a generating unit or facility for emergency reasons or a condition in which the generating equipment is unavailable for load due to unanticipated breakdown; represented in hours per unit.	N/A – value is provided for each unit
Forced Outage Rate	The ratio of the forced outages hours to the hours the unit was anticipated to be available for the reporting period.	Forced Outage Hours / Period Hours (excluding planned and unplanned outage hours)
Nameplate Capacity	The maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer.	N/A – value is provided for each unit

Plant and Unit List – Baseload and Peaker Units

BASELOAD UNITS

Plant	Units	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
San Juan	CT 5	X	X	X	X		
	STM 5	X	X	X	X		
	CT 6	X	X	X	X		
	STM 6	X	X	X	X		
	7	X	X	X	X		
	8	X	X	X	X		
	9	X	X	X	X		
	10	X	X	X	X		
Costa Sur	5	X	X	X	X		
	6	X	X	X	X		
Aguirre	1	X	X	X	X		
	2	X	X	X	X		
Palo Seco	1	X	X	X	X		
	2	X	X	X	X		
	3	X	X	X	X		
	4	X	X	X	X		
AES	AES 1	X	X	X	X		
	AES 2	X	X	X	X		
EcoEléctrica	ECO 1	X	X	X	X		
	ECO 2	X	X	X	X		
	STM 1	X	X	X	X		

PEAKER UNITS

Plant	Units	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
Cambalache	1	X	X	X		X	
	2	X	X	X		X	
	3	X	X	X		X	
Mayaguez	1A	X	X	X		X	
	1B	X	X	X		X	
	2A	X	X	X		X	
	2B	X	X	X		X	
	3A	X	X	X		X	
	3B	X	X	X		X	
	4A	X	X	X		X	
	4B	X	X	X		X	
Palo Seco (Inc. Mobile-Pack)	1-1	X	X	X		X	
	1-2	X	X	X		X	
	2-1	X	X	X		X	
	2-2	X	X	X		X	
	3-1	X	X	X		X	
	3-2	X	X	X		X	
	MP 1	X	X	X		X	
	MP 2	X	X	X		X	
	MP 3	X	X	X		X	
Aguirre CC	I-1	X	X	X		X	
	I-2	X	X	X		X	
	I-3	X	X	X		X	
	I-4	X	X	X		X	
	ST-1	X	X	X		X	
	II-1	X	X	X		X	
	II-2	X	X	X		X	
	II-3	X	X	X		X	
	II-4	X	X	X		X	
	ST-2	X	X	X		X	

PEAKER UNITS

Plant	Units	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
Other Peakers	Daguao 1-1	X	X	X		X	
	Daguao 1-2	X	X	X		X	
	Aguirre 2-1	X	X	X		X	
	Aguirre 2-2	X	X	X		X	
	Costa Sur 1-1	X	X	X		X	
	Costa Sur 1-2	X	X	X		X	
	Jobos 1-1	X	X	X		X	
	Jobos 1-2	X	X	X		X	
	Yabucoa 1-1	X	X	X		X	
	Yabucoa 1-2	X	X	X		X	
	Vega Baja 1-1	X	X	X		X	
	Vega Baja 1-2	X	X	X		X	
	Vieques 1	X	X	X		X	
	Vieques 2	X	X	X		X	
	Culebra 1	X	X	X		X	
	Culebra 2	X	X	X		X	
	Culebra 3	X	X	X		X	

Plant and Unit List – Renewable Projects

SOLAR PROJECTS

Projects	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
AES Ilumina						X
Cantera Martinó						X
San Fermín						X
Horizon Energy						X
Oriana Energy						X
Coto Laurel						X
Humacao						X

WIND AND LANDFILL PROJECTS

Projects	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
Pattern Santa Isabel						X
Landfill Gas Fajardo						X
Landfill Gas Toa Baja						X

HYDRO PLANTS

Projects	System Reserves	System Availability	System Heat Rate	All Metrics for Baseload Units	All Metrics for Peaker Units	Renewables Capacity Factor
Caonillas 1-1						
Caonillas 1-2						
Caonillas 2-1						
Dos Bocas 1						
Dos Bocas 2						
Dos Bocas 3						
Garzas 1-1						
Garzas 1-2						
Garzas 2-1						
Patillas 1-1						
Patillas 1-2						
Rio Blanco 1-1						
Rio Blanco 1-2						
Toro Negro 1-1						
Toro Negro 1-2						
Toro Negro 1-3						
Toro Negro 1-4						
Toro Negro 2-1						
Yauco 1-1						
Yauco 2-1						
Yauco 2-2						